7.0 Evaluation of Alternatives

CSO pollution control alternatives are developed and analyzed in this section with the goals of improving water quality within Alley Creek and Little Neck Bay and providing compliance with existing water quality standards. Each alternative is evaluated considering several parameters, including: feasibility of construction and implementation; improvements to the waterbody in terms of water quality parameters (dissolved oxygen, total coliform, fecal coliform and enterococcus) and aesthetics (floatables); significant reductions in the number of CSO events and annual CSO volume; and construction costs. At the conclusion of this section, a waterbody/watershed plan is selected that optimizes the above parameters cost-effectively, thus providing a higher quality water than is currently present in Alley Creek and Little Neck Bay.

In 1998, NYSDEC listed Little Neck Bay as a high priority waterbody for TMDL development with its inclusion the Section 303(d) List. The cause of the listing was pathogens due to CSO discharges and urban and storm runoff. Little Neck Bay continues to be listed on the 303(d) List for Pathogens through 2008 (most current list). "Alley Creek/Little Neck Bay Tributary" was listed for the first time on the 2004 Section 303(d) List as a high priority waterbody for oxygen demand. Sources of both pathogen impairment in Little Neck Bay and dissolved oxygen (DO) impairment in Alley Creek/Little Neck Bay Tributary are CSOs, urban runoff and stormwater. The Alley Creek and Little Neck Bay waters are included in Part 3c of the 2008 List. Part 3c lists "Waterbodies for which TMDL Development May be Deferred (Pending Implementation/Evaluation of Other Restoration Measures)." The Alley Creek/Little Neck Bay Tributary and Little Neck Bay are specifically noted that "Impairments to these waters are being addressed by 2005 Order on Consent with NYC directing the city to develop and implement watershed and facility plans to address CSO discharges and bring New York City waters into compliance with the Clean Water Act. This may include a revision of water quality standards based on a Use Attainability Analysis if fishable/swimmable goals of the CWA are not attainable. NYSDEC remains committed to the development of harbor-wide TMDLs for nutrients, pathogens and toxins. However, it is appropriate to defer development of separate TMDLs for these individual CSO-impacted waterbodies in light of the enforceable requirements of the NYC CSO Consent Order." (NYSDEC, 2008).

Alley Creek and Little Neck Bay have a history of CSO Facility Plan development as part of the East River CSO Facility Plan. As discussed in Section 5.0, CSO Facility Planning efforts were initiated in 1988 prior to issuance of the 1994 USEPA CSO Control Policy. The approach to improving water quality followed during the East River CSO Facility Planning, however, meets many of the CSO Policy requirements including an active public participation program and a rigorous evaluation that considered "a reasonable range of alternatives…sufficient to make a reasonable assessment of cost and performance" (59 FR 18692), although at the time there was no requirement for NYCDEP to develop a LTCP for Alley Creek and Little Neck Bay.

The requirement to develop a LTCP was introduced into the Tallman Island WPCP SPDES permit when the permit was modified in 2003. At that time, NYCDEP was well along in the planning and design of the recommended CSO Facility Plan. The initial Alley Creek CSO Facility Plan, accepted by NYSDEC in 1994, had undergone several modifications and has evolved into the current 2003 Alley Creek CSO Facility Plan (URS, 2003). The existing CSO

Facility Plan is described in detail in Section 5.7. Further, in January 2005, the CSO Order on Consent required that the City complete the construction of various aspects of the 2003 Alley Creek CSO Facility Plan recommendations.

This WB/WS Facility Plan, therefore, is based on the 2003 Alley Creek CSO Facility Plan recommendations as the starting point for assessing water quality and the evaluation of CSO control alternatives in the Alley Creek and Little Neck Bay assessment area. This WB/WS Plan examines controls beyond those provided in this CSO Facility Plan to determine if additional controls are required to comply with existing water quality standards. A WB/WS Plan is recommended in accordance with the USEPA CSO Policy requirements.

7.1 EVALUATION OF CSO CONTROL ALTERNATIVES IN THE ALLEY CREEK CSO FACILITY PLAN

NYCDEP submitted the East River CSO Facility Planning Project, Facility Plan Report to NYSDEC in 1996 (NYCDEP, 1996) The report describes the process used to screen and select CSO control alternatives for each of the East River WPCPs and tributary waterbodies. The approach first considered all reasonable measures for reducing CSO discharges to the East River, then reduced the comprehensive list of alternatives to those that had potential application in the tributary areas of the Tallman Island, Bowery Bay, Hunts Point, and Wards Island WPCPs given the nature of the waterbodies, tributary area, and the sewerage and collection facilities for each of the WPCPs. The options with the highest potential were fully developed and analyzed based on the following criteria:

- Attaining water quality goals;
- Public acceptance;
- Effective cost expenditures;
- Reliable operation;
- Regulatory concurrence; and
- Compatibility with other WPCPs under NYCDEP operation.

Numerous CSO control alternatives were considered during development of the 1994 Alley Creek CSO Facility Plan that became the 2003 CSO Facility Plan currently under construction. Many of the CSO control technologies considered were capable of being implemented in combination. As summarized in Table 7-1, the alternatives generally fell into four categories: source load reduction, storage, treatment, and waterbody measures. Issues of scaling (i.e., optimizing the utility of a particular alternative) were addressed only for those alternatives determined to have high potential for applicability during the preliminary screening.

This preliminary screening analysis highlighted necessary system improvements in addition to reducing the number of viable alternatives considerably. Improvements in the conveyance system capacity and improvements at the Tallman Island WPCP that would reduce CSO discharge were identified. Those alternatives that were not addressed in detail were generally dismissed based on a combination of cost and control limitations. In general, reasonable changes to land use, land use restrictions, and watershed BMPs were not expected to result in substantial pollutant discharge reduction within a timeframe suitable for facility planning.

Table 7-1. 1994 Alley Creek CSO Facility Plan, Preliminary Alternatives Screening

CSO Abatement Category	Alternative	Retained for Consideration at Tallman Island
Source Load Reduction	Infiltration/Inflow Control	No
	Pump Station Modification	No
	Regulator Maintenance/Modification	Yes
	Street Sweeping/Washing	No
	Public Education	Yes
Storage	Interceptors	Yes
	Trunk Sewers	No
	Storm Sewers	No
	Augmented Sewers	No
	Lined/Earthen Basin	No
	Concrete/Steel Tank	Yes
	Underground Silo	Yes
	Deep Tunnel	Yes
	Flow Balancing Method	No
Treatment	Treatment at WPCP Sites	Yes
	Flocculation/Sedimentation	No
	Swirl Concentrator	No
	Plate/Tube Settler	No
	Chlorination/Disinfection	Yes
Water Body Measures	In-Stream Aeration	Yes
	Dredging	No

CSO control alternatives retained from the preliminary screening process were considered further under a secondary screening process. The CSO control alternative that appeared to be the most favorable for CSO control in Alley Creek was storage. Disinfection by chlorination was also considered as a potential method for CSO control and was recommended for further evaluation in subsequent analyses.

The initial 1994 Alley Creek CSO Facility Plan recommended design and construction of a 9 MG underground tank sited within the cloverleaf of the southbound Cross Island Expressway's Northern Boulevard Exit. Flows in excess of the tank capacity were to be disinfected and discharged to Alley Creek through a new outfall, TI-025. The stored CSO would be pumped to the Tallman Island WPCP after the rainfall. Emergency bypass of the tank would be directed to TI-008. In addition, removal of floatables and settleables from TI-008 overflows was included.

7.2 HISTORICAL DEVELOPMENT OF THE ALLEY CREEK CSO FACILITY PLAN

As described in Section 5.1, the NYCDEP has been conducting CSO Facility Planning for several decades. Section 7.1 describes the initial Alley Creek CSO Facility Plan developed in 1994 as part of the East River CSO Project. The purpose was to develop a cost-effective and environmentally sound plan to improve the water quality in the East River and its tributaries including Alley Creek. The 1994 Alley Creek CSO Facility Plan has undergone several revisions prior to finalization of the Alley Creek CSO Facility Plan that is currently being implemented.

The major milestone plans are summarized in this section. Throughout the CSO planning process each plan has focused on (1) evaluation of water quality in comparison to State WQSs; (2) implementation of the nine minimum controls as per the USEPA CSO Control Policy; and (3) identification of required CSO control systems, and recommendations for implementation to meet NYSDEC water quality standards and address the USEPA CSO Control Policy.

7.2.1 1996 Alley Creek CSO Facility Plan

In February 1996, NYCDEP submitted to NYSDEC an updated CSO Facility Plan Report to present a comprehensive “stand alone” facilities plan for improving the water quality of all of the tributaries of the East River requiring CSO abatement. Water quality modeling performed subsequent to the 1994 Plan had indicated that the CSO discharges from TI-008 are a significant cause of the water quality degradation observed in Alley Creek and to a lesser extent Little Neck Bay. The 1996 report recommended a 7 MG tank based on a “knee of the curve” analysis predicated on the upgrade of Alley Creek to a Class SB water.

7.2.2 Development of September 2000 Alley Creek CSO Facility Plan

Subsequent to 1996, further analyses were performed using a more detailed receiving water model. To meet existing Alley Creek Class I water quality standards, upon reevaluation and further “knee of the curve” analyses, a 3 MG storage facility utilizing a new outfall sewer for in-line storage was recommended and proposed to NYSDEC. After further discussions between NYCDEP and NYSDEC it was agreed to increase the storage volume to 5 MG. The general concept of using an oversized outfall sewer for the dual purposes of augmenting hydraulic capacity of achieving CSO storage was accepted by NYCDEP and NYSDEC as the most feasible approach and was adopted as the design basis. The facility was a 5 MG Storage Conduit with inflatable dams.

7.2.3 Development of April 2003 Alley Creek CSO Facility Plan

Subsequent to 2000 and as a result of NYSDEC review and final NYCDEP input, the current, April 2003 Alley Creek CSO Facility Plan was developed (URS, 2003). This 2003 plan reflects the project currently under construction. The 5 MG storage is achieved with a fixed dam/storage conduit being constructed under two stages. The 5 MG is being constructed under Stage 1 and will be activated under Stage 2. Activation will consist of construction of the fixed weir within the outfall sewer at the downstream end near the outfall (TI-025) and removal of knock-out walls to allow flow over side weirs located along both sides of the outfall sewer. The new outfall sewer will function as part of the CSO storage facility.

The CSO capture characteristics of the 5 MG Alley Creek CSO Facility Plan included 54 percent CSO volume reduction, 70 percent TSS loading reduction and 66 percent reduction in BOD discharged to Alley Creek. Dissolved oxygen improvement was predicted for Alley Creek. These performance and water quality results were calculated from the analysis at that time. A detailed description of the elements of the CSO Facility Plan and Alley Creek CSO contract Phases and Stages is presented in Section 5.7.

7.3 ANALYSIS OF ADDITIONAL CSO CONTROL TECHNOLOGIES

A wide range of CSO control technologies was considered for application to New York City's Combined Sewer System (CSS). The technologies are grouped into the following general categories:

- Source Control
- Inflow Control
- Sewer System Optimization
- Sewer Separation
- Storage
- Treatment, and
- Receiving Water Improvement

Each technology is described below along with a discussion of the suitability of implementing it as a control technology for Alley Creek and Little Neck Bay. Table 7-2 lists the various CSO control technologies typically included within each of the general categories. Information is provided regarding implementation and operational factors that should be considered when evaluating the control technologies for a given locale. The table also indicates the general effectiveness of each control technology for four performance criteria including CSO volume reduction, bacteria reduction, floatables capture, and suspended solids reduction. It should be noted that a technology receiving "low" or "none" for some performance parameters does not preclude that technology from being considered for Alley Creek and Little Neck Bay. There are other areas where the control technology could be effective, such as improving dissolved oxygen in the waterbody, or the technology could be utilized in conjunction with another control technology.

7.3.1 Source Control

To control pollutants at their source, management practices can be applied where pollutants accumulate. Source management practices are described below:

- Public Education – Public education programs can be aimed at reducing (1) littering by the public and the potential for litter to be discharged to receiving waters during CSO events and (2) illegal dumping of contaminants in the sewer system that could be discharged to receiving waters during rain events. Public education programs cannot reduce the volume, frequency or duration of CSO overflows, but can help improve CSO quality by reducing floatable debris in particular. Public education and information is an integral part of any LTCP. Public Education is also an ongoing activity within NYCDEP (New York City Floatable Litter Reduction: Institutional, Regulatory and Public Education Programs, City of New York, Department of Environmental Protection, April 29, 2005).

Table 7-2. Assessment of CSO Control Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume	Bacteria	Floatables	Suspended Solids	
Source Control					
Public Education	None	Low	Med.	Low	Cannot reduce the volume, frequency or duration of CSO overflows.
Street Sweeping	None	Low	Med.	Med.	Effective at floatables removal, cost-intensive O&M. Ineffective at reducing CSO volume, bacteria and very fine particulate pollution.
Construction Site Erosion Control	None	Low	Low	Med.	Reduces sewer sediment loading, enforcement required. Contractor pays for controls.
Catch Basin Cleaning	None	Very Low	Med.	Low	Labor intensive, requires specialized equipment.
Industrial Pretreatment	Low	Low	Low	Low	There is limited industrial activity in and out of combined sewer area.
Inflow Control					
Storm Water Detention	Med.	Med.	Med.	Med.	Requires large area in congested urban environment, potential siting difficulties and public opposition, construction would be disruptive to affected areas, increased O&M.
Street Storage of Storm Water	Med.	Med.	Med.	Med.	Potential flooding and freezing problems, public opposition, low operational cost.
Water Conservation	Low	Low	Low	Low	Potentially reduces dry weather flow making room for CSO, ancillary benefit is reduced water consumption
Inflow/Infiltration Control	Low	Low	Low	Low	Infiltration usually lower volume than inflow, infiltration can be difficult to control
Green Solutions	Low.	Med.	Low	Med.	Site specific, requires widespread application across city to be effective, potential to be cost intensive in some areas.
Sewer System Optimization					
Optimize Existing System	Med.	Med.	Med.	Med.	Low cost relative to large scale structural BMPs, limited by existing system volume and dry weather flow dam elevations.
Real Time Control	Med.	Med.	Med.	Med.	Highly automated system, increased O&M, increased potential for sewer backups.
Sewer Separation					
Complete Separation	High	Med.	Low	Low	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads, requires homeowner participation.
Partial Separation	High	Med.	Low	Low	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads.
Rain Leader Disconnection	Med.	Med.	Low	Low	Low cost, requires home and business owner participation, potential for increased storm water pollutant loads.
Storage					
Closed Concrete Tanks	High	High	High	High	Requires large space, disruptive to affected area, cost intensive, aesthetically acceptable.

Table 7-2. Assessment of CSO Control Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume	Bacteria	Floatables	Suspended Solids	
Storage Pipelines/Conduits	High	High	High	High	Disruptive to affected areas, potentially expensive in congested urban areas, aesthetically acceptable, provides storage and conveyance.
Tunnels	High	High	High	High	Non-disruptive, requires little area at ground level, capital intensive, provides storage and conveyance, pump station required to lift stored flow out of tunnel.
Treatment					
Screening/ Netting Systems	None	None	High	None	Controls only floatables.
Primary Sedimentation[(1)]	Low	Med.	High	Med.	Limited space at WPCP, difficult to site in urban areas.
Vortex Separator (includes Swirl Concentrators)	None	Low	High	Low	Variable pollutant removal performance. Depending on available head, may require foul sewer flows to be pumped to the WPCP and other flow controls with increased O&M.
High Rate Physical/Chemical Treatment[1]	None	Med.	High	High	Limited space at WPCP, requires construction of extensive new conveyance conduits, high O&M costs.
Disinfection	None	High	None	None	Cost Intensive/Increased O&M.
Expansion of WPCP	High	High	High	High	Limited by space at WPCP, increased O&M.
Receiving Water Improvement					
Outfall Relocation	High	High	High	High	Relocates discharge to different area, requires the construction of extensive new conveyance conduits.
In-stream Aeration	None	None	None	None	High O&M, only effective for increasing DO, limited effective area.
Maintenance Dredging	None	None	None	None	Removes deposited solids after build-up occurs.
Solids and Floatables Controls					
Netting Systems	None	None	High	None	Easy to implement, potential negative aesthetic impact
Containment Booms	None	None	High	None	Simple to install, difficult to clean, negative aesthetic impact
Skimming Vessels	None	None	High	None	Easy to implement but limited to navigable waters
Manual Bar Screens	None	None	High	None	Prone to clogging, requires manual maintenance
Weir Mounted Screens	None	None	High	None	Relatively low maintenance, requires suitable physical configuration, must bring power to site
Fixed baffles	None	None	High	None	Low maintenance, easy to install, requires proper hydraulic configuration
Floating Baffles	None	None	High	None	Moving parts make them susceptible to failure
Catch Basin Modifications/Hooding	None	None	High	None	Requires suitable catch basin configuration and increases maintenance efforts

(1) Process includes pretreatment screening and disinfection

- Street Sweeping – The major objectives of municipal street cleaning are to enhance the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust and dirt, and to prevent these pollutants from entering storm or combined sewers. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. Studies on the effect of street sweeping on the reduction of floatables and pollutants in runoff have been conducted. New York City found that street cleaning can be effective in removing floatables. Increasing street cleaning frequency from twice per week to six times per week reduced floatables by about 42 percent on an item count basis at a very high cost. A significant quantity of floatables was found to be located on sidewalks that were not cleanable by conventional equipment. (HydroQual, 1995). However, in spite of these limitations, the Department of Sanitation of New York City (DSNY) does have a regular street sweeping program targeting litter reduction. The DSNY also has an aggressive enforcement program targeting property owners to minimize the amount of litter on their sidewalks. These programs are elements of New York City's City-Wide Comprehensive CSO Floatables Plan (City-Wide Comprehensive CSO Floatables Plan, Modified Facility Planning Report, City of New York, Department of Environmental Protection, July 2005)

  Studies, funded by the National Urban Renewal Program (NURP) during the late 1970s to the early 1980s, reported that street sweeping was generally ineffective at removing pollutants and improving the quality of urban runoff (MWCOG, 1983 and USEPA, 1983). The principal reason for this is that mechanical sweepers, employed at the time, could not pick up the finer particles (diameter < 60 microns). Studies have shown that these fine particles contain a majority of the target pollutants on city streets that are washed into sewer systems (Sutherland, 1995). In the early 1990s new vacuum-assisted sweeper technology was introduced that can pick up the finer particles along city streets. A recent study showed that these vacuum-assisted sweepers have a 70 percent pickup efficiency for particles less than 60 microns (Sutherland, 1995).

  Street sweeping only affects the pollutant concentration in the runoff component of combined sewer flows. Thus, a street sweeping program is ineffective at reducing the volume and frequency of CSO events. Furthermore, the total area accessible to sweepers is limited. Areas such as sidewalks, traffic islands, and congested street parking areas cannot be cleaned using this method. Although a street sweeping program employing high efficiency sweepers could reduce the concentrations of some pollutants in CSOs, bacteriological pollution originates primarily from the sanitary component of sewer flows. Thus, minimal reductions in fecal coliform and e. coli concentrations of CSOs would be expected.

- Construction Site Erosion Control – Construction site erosion control involves management practices aimed at controlling the washing of sediment and silt from disturbed land associated with construction activity. Erosion control has the potential to reduce solids concentrations in CSOs and reduce sewer cleanout O&M costs.

- Catch Basin Cleaning – The major objective of catch basin cleaning is to reduce conveyance of solids and floatables to the combined sewer system by regularly removing accumulated catch basin deposits. Methods to clean catch basins include manual, bucket, and vacuum removal. Cleaning catch basins can only remove an average of 1-2 percent of the BOD_5 produced by a combined sewer watershed (USEPA, 1977). As a result, catch basins cannot be considered an effective pollution control alternative for BOD removal. While catch basins can be effective in reducing floatables in combined sewers, catch basin cleaning does not necessarily increase floatables retention in the catch basin.

New York City has an aggressive catch basin hooding program to contain floatables within catch basins and remove the material through catch basin cleaning (City-Wide Comprehensive CSO Floatables Plan, Modified Facility Planning Report, City of New York, Department of Environmental Protection, July 2005).

- Industrial Pretreatment – Industrial pretreatment programs are geared toward reducing potential contaminants in CSO by controlling industrial discharges to the sewer system.

Summary of Source Control Technologies

The City already has myriad source-control programs in place. Public education and outreach with information are on-going NYCDEP activities. The City's CEQR program addresses construction site erosion control. The City-wide Comprehensive CSO Floatables Plan features both street sweeping and catch basin cleaning as source control elements. Finally, the City's successful industrial pretreatment program has been in place since 1987. Therefore, source controls are being effectively implemented to a satisfactory level.

7.3.2 Inflow Control

Inflow control involves eliminating or retarding storm water inflow to the combined sewer system, lowering the magnitude of the peak flow through the system, and thereby reducing overflows. Methods for inflow control are described below:

- Storm Water Detention – Storm water detention utilizes a surface storage basin or facility to capture storm water before it enters the combined sewer system. Typically, a flow restriction device is added to the catch basin to effectively block storm water from entering the basin. The storm water is then diverted along natural or man-made drainage routes to a surface storage basin or "pond-like" facility where evaporation and/or natural soil percolation eventually empties the basin. Such systems are applicable for smaller land areas, typically up to 75 acres, and are more suitable for non-urban areas. Such a system is not considered viable for a highly congested urban area such as New York City. Storm water blocked from entering catch basins would be routed along streets to the detention pond which would be built in the urban environment. Extensive public education and testing is required to build support for this control and to address public concerns such as potential unsafe travel conditions, flood damage, and damage to roadways.

- Street Storage of Stormwater – Street storage of storm water utilizes the City's streets to temporarily store storm water on the road surface. Typically, the catch basin is modified to include a flow restriction device. This device limits the rate at which surface runoff enters the combined sewer system. The excess stormwater is retained on the roadway entering the catch basin at a controlled rate. Street storage can effectively reduce inflow during peak periods and can decrease CSO volume. It also can promote street flooding and must be carefully evaluated and planned to ensure that unsafe travel conditions and damage to roadways do not occur. For these reasons, street storage of stormwater is not considered a viable CSO control technology in New York City.

- Water Conservation, Infiltration/Inflow (I/I) Reduction - Water conservation and infiltration control are both geared toward reducing the dry weather flow in the system, thereby allowing the system to accommodate more CSO. Water conservation includes measures such as installing low flow fixtures, public education to reduce wasted water, leak detection and correction, and other programs. The City of New York has an on-going water conservation and public education program. The NYCDEP's ongoing efforts to save water include: installing home meters to encourage conservation; use of sonar equipment to survey all water piping for leaks; replacement of approximately 70 miles of old water supply pipe a year; and equipping fire hydrants with special locking devices. These programs in conjunction with other on-going water conservation programs have resulted in the reduction of water consumption by approximately 200 MG per day over a 12 year period.

  Infiltration is groundwater that enters the collection system through leaking pipe joints, cracked pipes, manholes, and other similar sources. Excessive amounts of infiltration can take up hydraulic capacity in the collection system. In contrast, inflow in the form of surface drainage is intended to enter the CSS. For combined sewer communities, sources of inflow that might be controlled include leaking or missing tide gates and inflow in the separate sanitary system located upstream of the CSS. New York City has achieved significant reductions in wastewater flow through its existing water conservation program.

- Green Solutions/Low Impact Development – For the purposes of this Waterbody/Watershed Facility Plan, "green solutions" encompasses a range of techniques that includes stormwater best management practices (BMPs) and low-impact development (LID). The goal of green solutions is to mimic predevelopment site hydrology to capture, infiltrate, evaporate, and detain runoff to reduce both the volume of stormwater generated by a site and its peak overflow rate, thereby improving the quality of the stormwater. Green solutions are promising, and their potential benefits extend beyond stormwater management to include habitat restoration, heat island mitigation, and urban aesthetics.

  Data are available to assess the cost and benefits of green solutions to undeveloped sites. However, few studies have been conducted for applying green solutions to urban areas such as New York City, where high-density development, existing infrastructure, and land acquisition issues tend to counterbalance the environmental benefits of implementation. In addition, input and acceptance by numerous City agencies will be necessary, including the Department of Parks and Recreation, the Department of Transportation, and the Department of Buildings.

  Common green solutions are described below:

  - Bioretention (rain garden) – a planting bed or landscaped area used to hold runoff and to allow it to infiltrate.

- Filter Strips – a band of vegetation located between the runoff location and the receiving channel or waterbody. Overland flow over the filter strip allows infiltration and filtering of storm water.

- Vegetated Buffers – a strip of vegetation around such areas as water bodies to provide a means to rain to infiltrate into the soil. This slows and disperses storm water and allows some trapping of sediment.

- Grassed Swales – depressions designed to collect, treat, and retain runoff from a storm event. Swales can be designed to be dry or wet (with standing water) between rain events. Wet swales typically contain water tolerant vegetation and use natural processes to remove pollutants.

- Rain Barrels – a barrel placed at the end of a roof downspout to capture and hold runoff from roofs. The water in the barrel must be manually emptied onto the ground, or it can be put to beneficial use to water vegetation. The barrel top typically has a completely sealed lid and a downspout diverter to direct overflow back to the roof leader.

- Cisterns – an oversized or underground tank that stores rain water from roofs for nonpotable reuse.

- Subsurface Open Bottom Detention Systems – an excavated trench backfilled with stone, perforated pipes or manufactured storm chambers to create a subsurface basin or trench that provides storage for water, allows stormwater to infiltrate, and releases water to the sewer system at a controlled rate.

- Blue Roofs – the practice of constructing rooftop detention to temporarily store and gradually drain rainwater off a building's rooftop via a controlled flow roof drain.

- Rooftop Green Roofs – the practice of constructing pre-cultivated vegetation mats on rooftops to capture rainfall, thereby reducing runoff and CSO.

- Increased Tree Cover – planting trees in the City to capture a portion of rainfall.

- Permeable Pavements – a type of surface material that reduces runoff by allowing precipitation to infiltrate through the paving material and into the earth.

Green solutions are distributive in nature (i.e., constructed within individual properties or in right-of-ways). The time necessary for enough of these source control measures to be in place and to have a substantial impact on stormwater inflows to the combined sewers is significantly longer than implementing more traditional CSO abatement approaches. In urban areas, it is not reasonable to demolish existing development or infrastructure just for the purpose of green solutions alone. It is generally accepted that green solutions are reasonable to apply with new development or construction within an urban area. Trenches excavated for street and sidewalk construction allow substantial BMP construction cost savings. Municipal codes or rules for new development may allow green solutions to be incorporated as part of site plans and building design and minimize potential economic hardship for property owners. In the case of existing development, significant participation and cooperation of business and private property owners as well as additional evaluations are necessary.

NYCDEP and other agencies, as described in the Mayor's Sustainable stormwater Management Plan, plan to conduct a number of pilot studies to assess the effectiveness of BMPs in New York City's urban environment. While there are numerous published studies about stormwater BMPs from other municipalities, various public agencies, and environmental organizations, there is a critical data gap of specific information related to the effectiveness and appropriateness of the use of these technologies within New York City.

The pilot projects are intended to fill that data gap through the conduction of multi-year studies to implement and monitor innovative stormwater treatment and volume reduction BMP technologies. The pilot projects will include the design, construction and monitoring of various BMPs to reduce runoff and associated stormwater pollutant loadings into the City's combined and storm sewers. Runoff will be directed into swales, wetlands, and BMPs rather than to combined and storm sewers discharging to waterbodies. As part of the pilot studies, stormwater capture volume and pollutant removal rates of each of the technologies will be documented. Once these technologies are proven to be effective, a wider citywide application of these technologies would be evaluated. See Section 5.8 for more detailed information about current NYCDEP pilot projects and evaluations of green solutions.

The anticipated environmental benefits of identifying Green Site Design (GSD) or BMPs for use in New York City can be grouped into three categories. The first category relates to the capture of the "first flush" of stormwater that contains the highest concentration of nitrogen, other nutrients and urban pollutants and reduce these discharges to the City's sewer system and surrounding waterbodies. The second category relates to reducing the volume of stormwater entering the combined sewer system. A reduction in the volume of stormwater entering the combined sewer system will also increase the ability of the City's WPCPs to properly treat a greater volume of sanitary wastewater and reduce the volume of sanitary wastewater discharged in CSOs. The third category relates to returning stormwater to the landscape and subsurface environments in order to benefit ecological communities and provide opportunities for open space.

The timeline for the study and evaluation of the green solutions further described in Section 5.8 will extend beyond the Consent Order milestones for delivery of approvable Waterbody/Watershed Facility Plans to NYCDEC; as a result, further evaluation of Source or Inflow Controls in the Gowanus Canal Waterbody/Watershed Facility Plan is not possible. However, green solutions will continue to undergo the rigorous level of evaluation necessary for programmatic implementation by the City of New York through parallel planning efforts as described in detail in Section 5. NYCDEP plans to provide updates on these evaluations and incorporate the most promising technologies into the CSO program where possible, cost-effective, and environmentally beneficial. Any solution satisfying these criteria could be included through a future modification when the WB/WS plan is converted to a Drainage Basin Specific Long Term Control Plan, a 5-

year update of a Drainage Basin Specific Long Term Control Plan or in the subsequent City-Wide Long Term Control Plan.

Summary of Inflow Control Technologies

Stormwater storage and detention are not viable options for the City of New York because of its highly urbanized character and the need for conveyance infrastructure to divert stormwaters from the combined sewers to the detention site. Further, any above-ground infrastructure would introduce public safety concerns associated with flooding, traffic and standing water health issues. In contrast, the remaining inflow control technologies have been successfully implemented by the City of New York. As noted above green solutions will continue to undergo the rigorous level of evaluation necessary for programmatic implementation by the City through parallel planning efforts. The NYCDEP's ongoing efforts in water conservation include home metering, sonar leak detection surveys, annual replacement of approximately 70 miles of old water supply piping, locking fire hydrants, and an ongoing public education program. These conservation efforts have collectively resulted in the reduction of water consumption by approximately 200 MGD over a 12 year period. Based on the fact that these technologies for storage and detention are either unfeasible or have been implemented to a satisfactory degree, inflow control is not retained for further consideration in the Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan.

7.3.3 Sewer System Optimization

This CSO control technology involves making the best use of existing facilities to limit overflows. The techniques are described below:

- Optimize Existing System – This approach involves evaluating the current standard operating procedures for facilities such as pump stations, control gates, inflatable dams, and treatment facilities to determine if improved operating procedures can be developed to provide benefit in terms of CSO control.

  As described in Section 5, previous and ongoing NYCDEP projects routinely consider alternatives to operating procedures to optimize the existing system. The operating procedures are satisfactorily implemented under the existing system. Elevated static weir heights, opportunities for inflatable dams and/or control gates, and similar alternatives within the sewer system pipes have been eliminated from further consideration in light of the unacceptably high risk that these alternatives would pose to flooding in the community. However, as the Alley Creek project is implemented and the existing system changes, NYCDEP will continue to look for new opportunities to optimize the system.

- Real Time Control (RTC) – RTC is any response, manual or automatic, made in response to changes in the sewer system condition. For example, sewer level and flow data can be measured in "real time" at key points in the sewer system and transferred to a control device such as a central computer where decisions are made to operate control components (such as gates, pump stations or inflatable dams) to maximize use of the existing sewer system and to limit overflows. Data monitoring need not be centralized since local dynamic controls can be used to control regulators to prevent localized flooding. However, system-wide dynamic controls are typically used to implement control objectives such as maximizing flow to the WPCP or transferring flows from one portion of the CSS to another to fully utilize the system. Predictive control, which incorporates use of weather forecast data is also possible, but is complex and requires sophisticated operational capabilities.

RTC can reduce CSO volumes where in-system storage capacity is available. In-system storage is a method of using excess sewer capacity by containing combined sewage within a sewer and releasing it to the WPCP after a storm event when capacity for treatment becomes available. Methods of equipping sewers for in-system storage include inflatable dams, mechanical gates and increased overflow weir elevations. RTC is being developed in other cities such as Louisville, Kentucky; Cleveland, Ohio; and Quebec, Canada. Refer to Figure 7-1 for a diagram of an example inflatable dam system. New York City has conducted an extensive pilot study of the use of inflatable dams (O'Brien & Gere, 2004) within the City's combined sewers. This pilot study involved the use of inflatable dams and RTC to control them at two locations in the Bronx: Metcalf Avenue and Lafayette Avenue. Through this study, the City found that the technology was feasible for further consideration. However, widespread application of inflatable dams and RTC is limited in NYC as it does not provide for the following: (1) storage of large enough volumes of combined sewage; (2) areas where tributary water quality is degraded, and; (3) adequate improvements in water quality. In addition to these factors, the City has considerable doubts about the viability of inflatable dams. At other locations in the city where inflatable dam systems were being designed, acquiring a bidder was difficult. Historically, there were only two manufacturers of inflatable dam systems. One no longer manufactures the dams and the other has curtailed service in the United States market. This creates a problem purchasing the system and does not ensure a reliable supply of replacement parts. While the use of dams may be manageable for a limited number of facilities, wide-spread application of dams may lead to ineffective operation creating a massive maintenance and operation issue and possible flooding due to malfunctions. The inflatable dams at Metcalf Avenue and Lafayette have been decommissioned and removed.

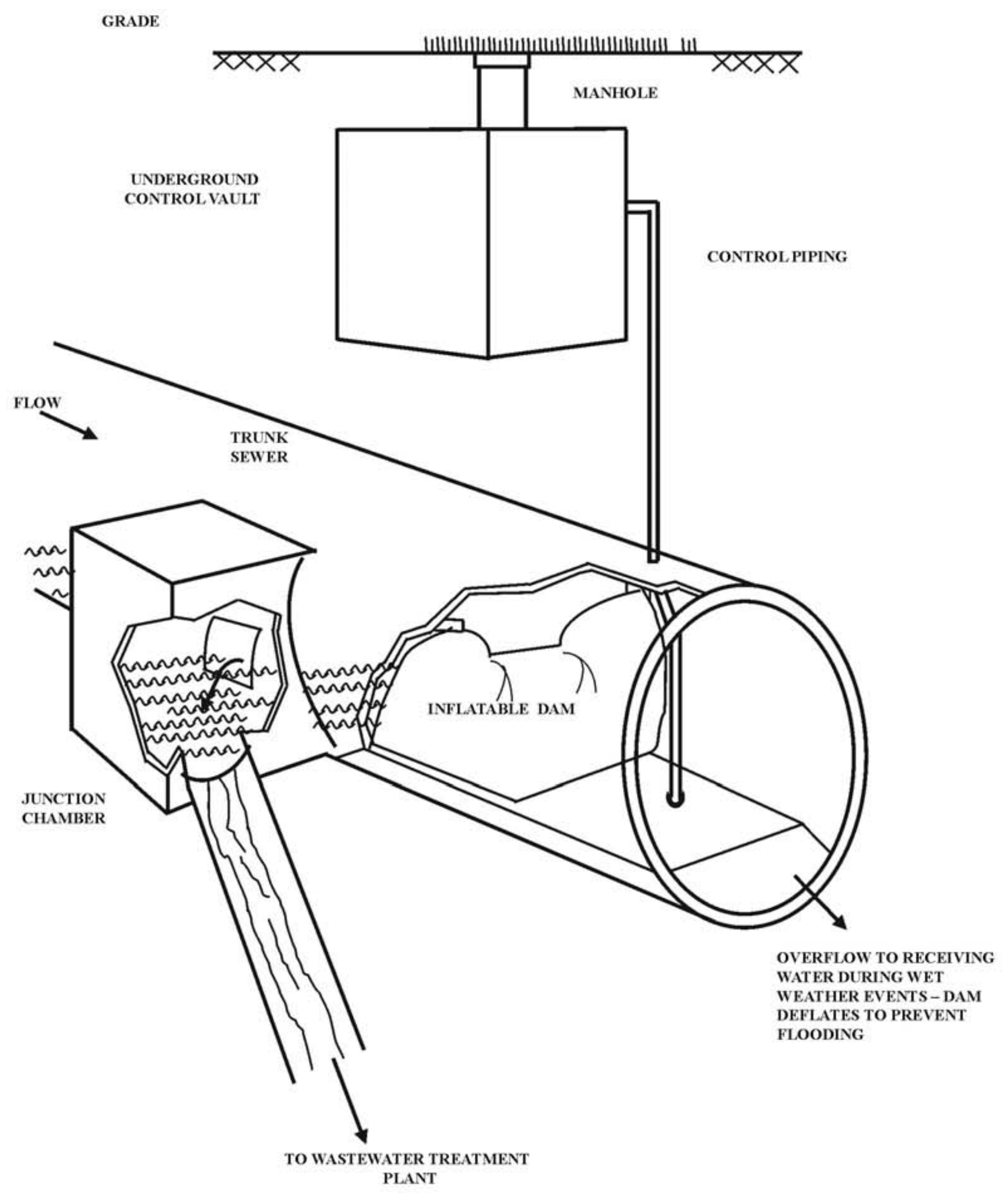
Real time control will not be retained for further consideration when evaluating potential alternatives for CSO control in Alley Creek.

Summary of Sewer System Optimization Technologies

The optimization of the sewer system through RTC of in-line technologies is not feasible within the Alley Creek and Little Neck Bay portion of the Tallman Island WPCP and was therefore eliminated from further consideration in the Waterbody/Watershed Facility Plan.

7.3.4 Sewer Separation

Sewer separation is the conversion of a combined sewer system into a system of separate sanitary sewers and storm sewers. This alternative prevents sanitary wastewater from being discharged to receiving waters. However, when combined sewers are separated, storm sewer discharges to the receiving waters will increase since storm water will no longer be captured and



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Inflatable Dam System

FIGURE 7-1

treated in the combined sewer system. Loading of some pollutants, such as floatables, would increase with sewer separation because concentrations of these pollutants are higher in storm water than in sanitary sewage. In addition, this alternative involves substantial excavation that would exacerbate street disruption problems within the City.

Varying degrees of sewer separation could be achieved as described below and illustrated in Figure 7-2. The simplest is to disconnect rain leaders from the combined sewer system and divert the stormwater elsewhere, such as a dry well, vegetation bed, lawn, storm sewer, or the street depending on the location. Partial separation can be accomplished separating the combined sewers only in the streets or other public rights-of way. This is accomplished by constructing either a new sanitary wastewater system or a new stormwater system. Complete separation**, i**n addition to separation of sewers in the streets, stormwater runoff from private residences or buildings (i.e. rooftops and parking lots) is also separated.

Complete separation is almost impossible to attain in New York City since it requires re-plumbing of apartment buildings, office buildings and commercial buildings where roof drains are interconnected to the sanitary plumbing inside the building and requires construction of a new conduit to convey stormwater to an appropriate destination or end use. In urban areas there is a lack of pervious areas to disperse the storm runoff into the ground, leading to nuisance flooding, and wet foundations and basements. These risks have led to the prohibition of stormwater disconnections from the combined sewers in the City Building Code. In addition, the widespread excavation and lengthy timeframes required to broadly implement separation would lead to unacceptable street disruptions and may not be feasible in areas with dense buried infrastructure.

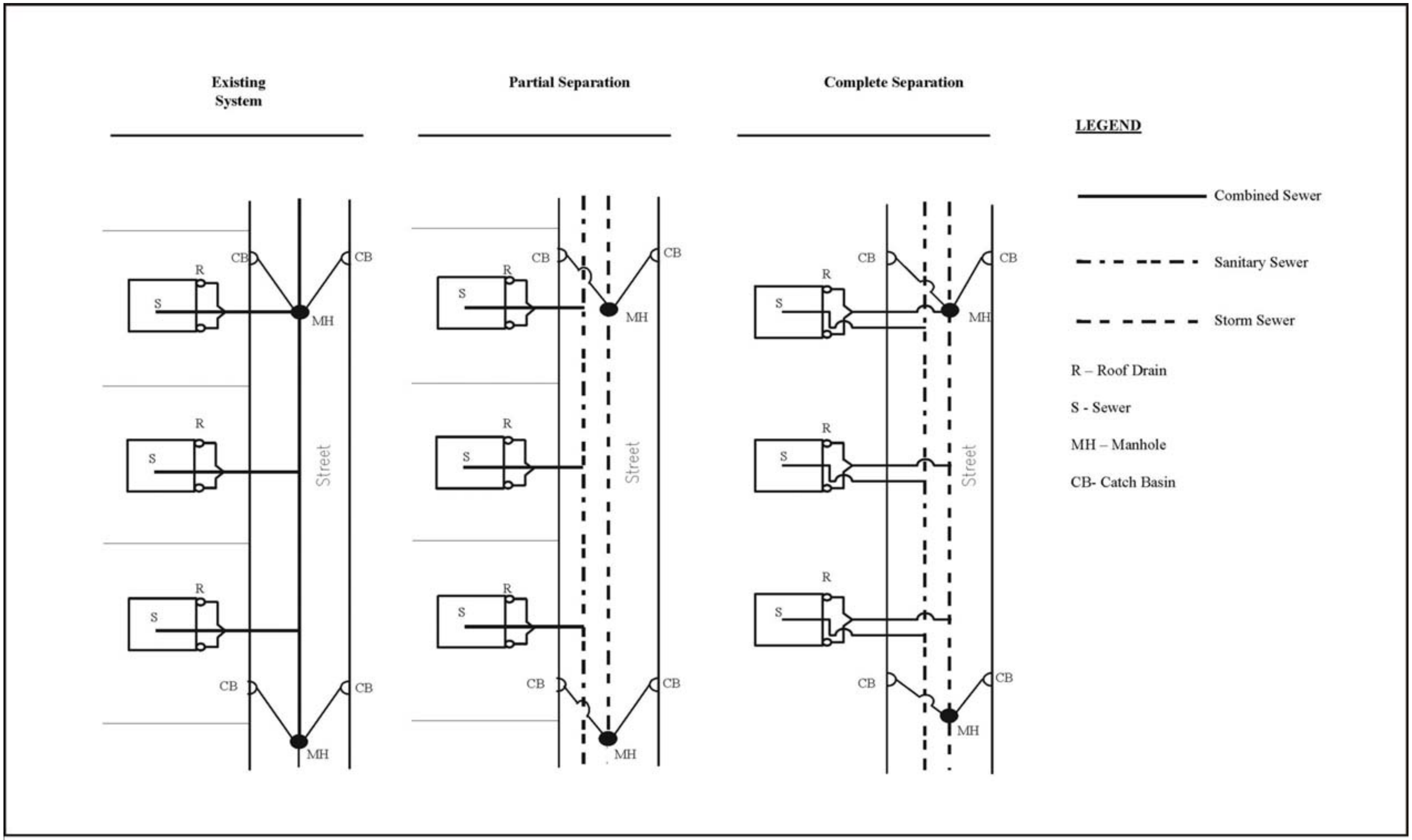
In areas that are adjacent to the waterbody, partial separation can be accomplished through construction of high level storm sewers (HLSS). This is a potentially feasible alternative that is featured in the New York City Mayor's "PlaNYC 2030" initiative, and is being implemented by NYCDEP in select locations throughout the City undergoing new development.

Summary of Sewer Separation

In the Alley Creek and Little Neck Bay watershed, most of the non-parkland sewered areas adjacent to the waterbodies are already separately sewered (see Figure 1-2). Therefore, although NYCDEP will continue to promote and support opportunities for local partial separation through the construction of HLSS as new development continues into the future, partial separation will not be retained as an alternative for the Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan.

7.3.5 Storage

The objective of retention basins (also referred to as off-line storage) is to reduce overflows by capturing combined sewage in excess of WPCP capacity during wet weather for controlled release into wastewater treatment facilities after the storm. Retention basins can provide a relatively constant flow into the treatment plant and thus reduce the size of treatment facilities required.



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Sewer Separation Alternatives

FIGURE 7-2

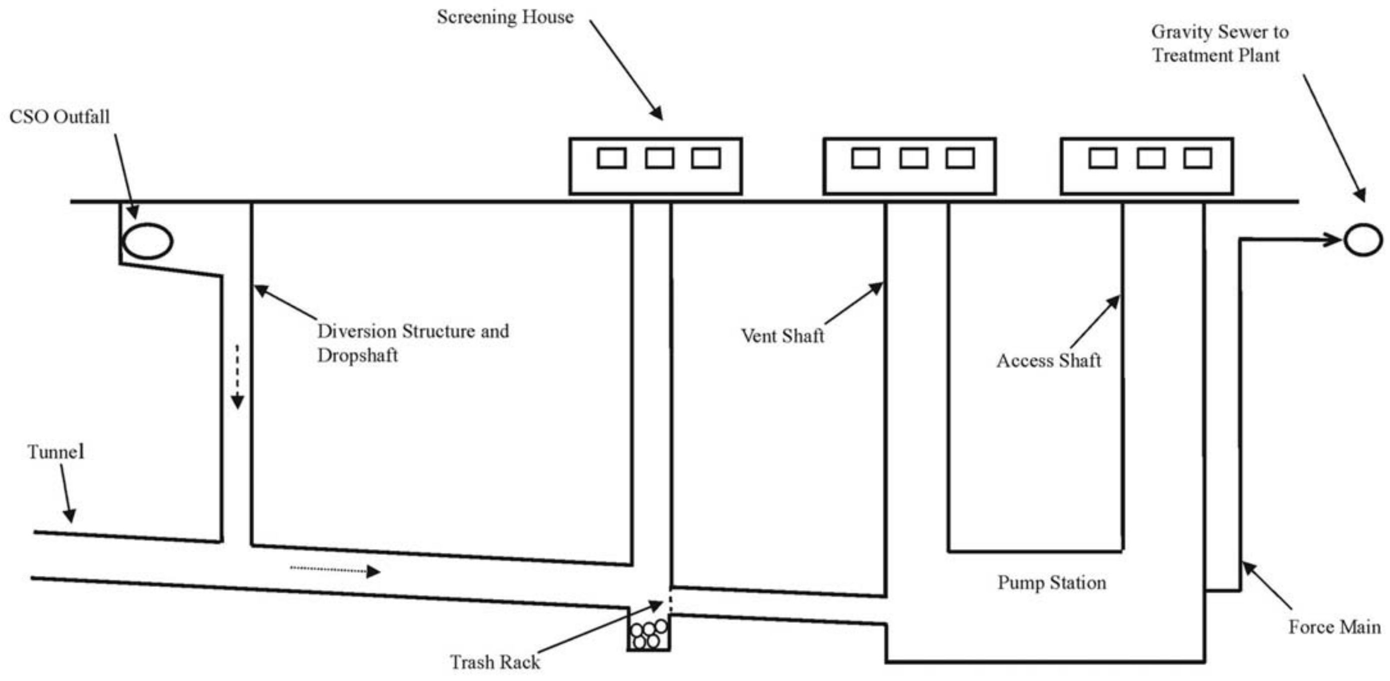
Retention basins have had considerable use and their performance is well documented. Retention facilities can be located at overflow points or near dry weather or wet weather treatment facilities. A major factor determining the feasibility of using retention basins is land availability. Operation and maintenance costs are generally small, typically requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required. Many demonstration projects have included storage of peak storm water flows, including those in Richmond, VA; Chippewa Falls, WI; Boston, MA; Milwaukee, WI; and Columbus, OH.

The following subsections discuss the most common types of CSO retention facilities:

- Closed Concrete Tanks – Closed concrete tanks are similar to open tanks except that the tanks are covered and include mechanical facilities to minimize their aesthetic and environmental impact. Closed concrete tanks typically include odor control systems, washdown/solids removal systems and access for cleaning and maintenance. Closed concrete tanks have been constructed below grade such that the overlying surface can be used for parks, playgrounds, parking or other light public uses.

- Storage Pipelines/Conduits – Large diameter pipelines or conduits can provide significant storage in addition to the ability to convey flow. The pipelines are fitted with some type of discharge control to allow flow to be stored within the pipeline during wet weather. After the rain event, the contents of the pipeline are allowed to flow by gravity along its length. A pipeline has the advantage of requiring a relatively small right-of-way for construction. The primary disadvantage is that it takes a relatively large diameter pipeline or cast-in-place conduit to provide the volume required to accommodate large periodic CSO flows. This is a greater construction effort than a pipeline used only for conveyance. For large CSO areas, pipeline size requirements may be so large that construction of a tunnel is more feasible.

- Tunnels – Tunnels are similar to storage pipelines in that they can provide both significant storage volume and conveyance capacity. Tunnels have the advantage of causing minimal surface disruption and of requiring little right-of-way for construction. Excavation to construct the tunnel is carried out deep beneath the city and therefore does not impact traffic. The ability to construct tunnels at a reasonable cost depends on the geology. Tunnels have been used in many CSO control plans including Chicago, Illinois; Rochester, New York; Cleveland, Ohio; Richmond, Virginia; and Toronto, Canada, among others. A schematic diagram of a typical storage tunnel system is shown in Figure 7-3. The storage tunnel stores flow and then conveys it to a tunnel dewatering station where floatables are removed at a screening house. Then flows are pumped for conveyance to the WPCP.



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Storage Tunnel Schematic

FIGURE 7-3

- Weirs – Bending weirs and static weirs such as stop logs are used to increase pre-overflow water levels, typically in interceptors and trunk sewers. Increased water levels in these applications provide additional interceptor flow capacity as well as storage of sewage and CSO. The bending weirs can be installed in both new and existing regulators. When installed in new regulators, the bending weir flow characteristics permit shorter weir lengths and thus an overall smaller structure. When installed in an existing regulator, often the bending weir can be installed directly onto the existing weir. Some modification to the structure is required to support the vertical end sections of the weir components. Reduction in CSO volume can only be evaluated, however, on a case-by-case basis.

  For the Alley Creek Waterbody/Watershed Facility Plan alternatives, weirs were investigated for increased storage when applied to Chamber 6, the chamber that directs CSO to the Tank and at the end of the tank itself. A general schematic of a bending weir is shown in Figure 7-4.

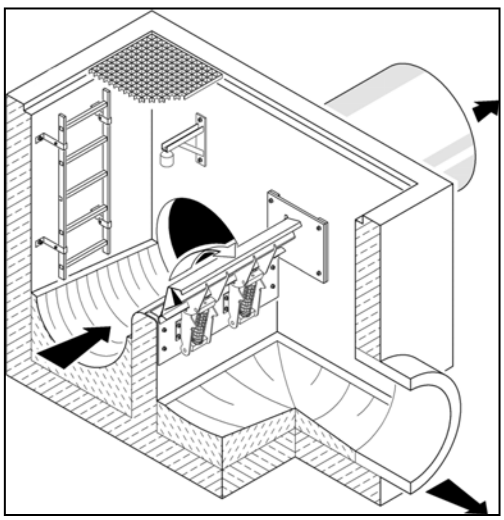


Figure 7-4. Bending Weir Schematic

Summary of Storage

Storage is the CSO control category selected and being implemented for Alley Creek and Little Neck Bay Facility Plan. Storage is the CSO control category selected for alternatives required to achieve a high degree of CSO reduction resulting in small numbers of overflow events and the achievement of total CSO reduction resulting in the elimination of overflow events. The Waterbody/Watershed storage technology selected was tanks, since there was only one location where storage was needed. In addition, the inclusion of weirs as an option to the Alley Creek Retention Facility already under construction was evaluated. Tunnels were not retained for further consideration in the Alley Creek and Little Neck Bay alternatives evaluation.

7.3.6 Treatment

Treatment alternatives include technologies intended to separate solids and/or floatables from the combined sewage flow, disinfect for pathogens treatment, or provide secondary treatment for some portion of the combined flow. The following are types of treatment technologies:

- Screening;
- Primary Sedimentation;
- Vortex Separation;
- High-rate Physical/Chemical Treatment;
- Disinfection; and
- Expansion of WPCP Treatment

The City of New York has experience with each of these treatment alternatives to varying degrees.

- Screening – The major objective of screening is to provide high rate solids/liquid separation for combined sewer floatables and debris thereby preventing floatables from entering receiving waters. Removal of solid material from a waste stream depends on the spacing or opening size of the screening barrier. Flow passes through the openings and solids are retained on the screen surface. The categories of screens applicable to CSO outfall applications can be in the shape of a rotary drum or linearly horizontal or vertically positioned.

  Trash racks are screens intended to remove large objects from overflow and have a clear spacing between approximately 1.5 to 3.0 inches. Manually cleaned bar racks are similar and have clear spacing between 1.0 to 2.0 inches. Both trash racks and bar racks must be either manually raked and the screenings allowed to drain before disposal, or cleaned with a Vactor truck. Mechanically cleaned bar screens typically have clear spacing between 0.25 and 1.0 inches. Bars are mounted 0 to 39 degrees from the vertical and rake mechanisms periodically remove material trapped on the bar screen. Facilities are typically located in a building to house collected screenings after a CSO events and then transported to a landfill.

  Fine screens in CSO facilities typically follow bar screens and have openings between 0.010 and 0.5 inches. Proprietary screens such as ROMAG have been specifically designed for wet weather applications. These screens retain solids on the dry weather side of the system so they can be conveyed to the wastewater treatment plant with the sanitary wastewater thereby minimizing the need for manual collection of screenings. Depending on the type of screening technology used, facilities may require a building to house the screens and store the retained screenings that then must be collected after each CSO event and transported to a landfill.

Manually cleaned screens for CSO control at remote locations have not been widely applied due to the need to clean screens, and the potential to cause flooding if screens blind. Mechanically cleaned screens have had much greater application at CSO facilities. Due to the widely varying nature of CSO flow rates, even mechanically cleaned screens are subject to blinding under certain conditions. In addition, the screening must be housed in a building to address aesthetic concerns and may require odor facilities as well. Fine screens have had more limited application for CSOs in the United States. ROMAG reports that over 250 fine screens have been installed in Europe and several screens have been installed in the United States (USEPA, 1999a).

- <u>Primary Sedimentation</u> – The objective of sedimentation is to produce a clarified effluent by gravitational settling of the suspended particles that are heavier than water. It is one of the most common and well-established unit operations for wastewater treatment. Sedimentation tanks also provide storage capacity, and disinfection can occur concurrently in the same tank. It is also very adaptable for chemical additives, such as lime, alum, ferric chloride, and polymers, which provide higher suspended solids and BOD_5 removal. Many CSO control demonstration projects have included sedimentation. These include Dallas, Texas; Saginaw, Michigan; and Mt. Clements, Michigan (USEPA, 1978). Studies on existing storm water basins indicate suspended solids removals of 15 to 89 percent; BOD_5 removals of 10 to 52 percent (USEPA, 1978, Fair and Geyer, 1965, Ferrara and Witkowski, 1983, Oliver and Gigoropolulos, 1981).

  The NYCDEP's WPCPs are designed to accept their respective 2×DDWF for primary treatment during wet weather events. As such, NYC already controls a significant portion of combined sewage through the use of this technology.

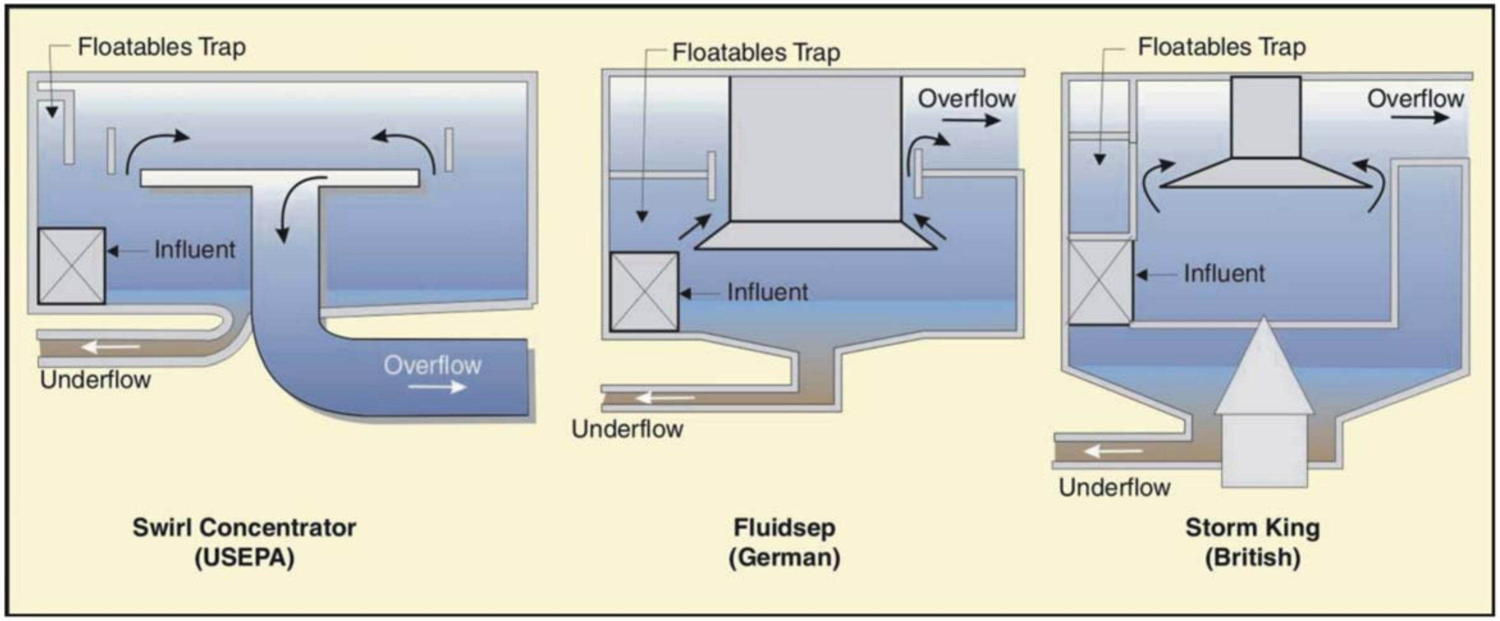
- <u>Vortex Separation</u> – Vortex separation technologies currently marketed include: USEPA Swirl Concentrator, Storm King Hydrodynamic Separator of British design, and the FluidSep vortex separator of German design. Although each of the three is configured somewhat differently, the operation of each unit and the mechanisms for solids separation are similar. Flow enters the unit tangentially and is directed around the perimeter of a cylinder, creating a swirling, vortex pattern. The swirling action causes solids to move to the outside wall and fall toward the bottom, where the solids concentrated flow is conveyed through a sewer line to the WPCP. The overflow is discharged over a weir at the top of the unit. Various baffle arrangements capture floatables that are subsequently carried out in the underflow. Principal attributes of the vortex separator are the ability to treat high flows in a very small footprint, and a lack of mechanical components and moving parts, thereby reducing operation and maintenance.

  Vortex separators have been operated in a number of cities, including Decatur, Illinois, Columbus, Georgia, Syracuse and Rochester, New York, Lancaster, Pennsylvania, West Roxbury, Massachusetts, Indianapolis, Indiana; and Toronto, Ontario, Canada. Vortex separator prototypes have achieved suspended solids removals of 12 to 86 percent in Lancaster, 18 to 55 percent in Syracuse and 6 to 36 percent in West Roxbury. BOD_5 removals from 29 to 79 percent have been achieved with the swirl concentrator prototype in Syracuse(Alquier, 1982).

New York City evaluated the performance of three swirl/vortex technologies at a full-scale test facility (133 MGD each) at the Corona Avenue Vortex Facility (see Figure 7-5). The purpose of the test was to demonstrate the effectiveness of the vortex technology for control of CSO pollutants, primarily floatables, oil and grease, settleable solids and total suspended solids. The two-year testing program, initiated in late 1999, evaluated the floatables removal performance of the facility for a total of 22 wet weather events. Overall, the results indicated that the vortex units provided an average floatables removal of approximately 60 percent during the tested events. Based on the results of the testing, NYCDEP concluded that widespread application of the vortex technology is not effective for control of settleable solids and was not a cost effective way to control floatables. As such, the application of this technology will be limited and other methods to control floatable discharges into receiving waters will need to be assessed.

Also, the performance of vortex separators has been found to be inconsistent in other demonstrations. A pilot study in Richmond, Virginia showed that the performance of two vortex separators was irregular and ranged from <0 percent to 26 percent with an average removal efficiency of about 6 percent (Greeley and Hansen, 1995). The performance of vortex separators is also a strong function of influent TSS concentrations. A high average influent TSS concentration will yield a higher percent removal. As a result, if influent CSO is very dilute with storm water, the overall TSS removal will be low. Suspended solids removal in the beginning of a storm may be better if there is a pronounced first flush period with high solids concentrations (City of Indianapolis, 1996). Removal effectiveness is also a function of the hydraulic loading rate with better performance observed at lower loading rates. Furthermore, one of the advantages of vortex separation, the lack of required moving parts, requires sufficient driving head. Based on the poor results of the testing at the Corona Vortex Facility (NYCDEP, 2003b; HydroQual, 2005e), and the general lack of available head, vortex separators have been removed from further consideration in New York City.

<u>High Rate Physical/Chemical Treatment (HRPCT)</u> – High rate physical/chemical treatment is a traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance. The pretreatment requirements for high rate treatment are screening and degritting, identical to that required prior to primary sedimentation. The first stage of HRPCT is coagulant addition, where ferric chloride, alum or a similar coagulant is added and rapidly mixed into solution. Degritting may be incorporated into the coagulation stage with a larger tank designed for gravity settling of grit material. The coagulation stage is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Also in this stage recycled sludge or micro sand from the settling stage is added back in to improve the flocculation process. Finally, the wastewater enters the gravity settling stage that is enhanced by lamella tubes or plates. Disinfection, which is not part of the HRPCT process, typically is performed on the HRPCT effluent. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or wasted periodically when sludge blanket depths become too high.



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Schematic Diagrams of the Three Vortex Technologies Tested at CAVF

FIGURE 7-5

Pilot testing of HRPCT was performed from May through August 1999 at the 26th Ward WPCP in Brooklyn. Equipment from three leading HRPCT manufacturers: the Ballasted Floc Reactor™ from Microsep/US Filter, the Actiflo™ from Kruger and the Densadeg 4D™ from Infilco Degremont was tested. Pilot testing suggested good to excellent performance on all units, often in excess of 80 percent for TSS and 50 percent for BOD_5. However, operational challenges suggested the need for further testing, which was to be performed in a demonstration-scale facility to be located at the Port Richmond WPCP on Staten Island. Subsequent facility planning did not result in any opportunities to apply this technology for CSO abatement in New York City. Consequently, the demonstration project has been indefinitely postponed.

- Disinfection – The major objective of disinfection is to control the discharge of pathogenic microorganisms in receiving waters. Disinfection of combined sewer overflow is included as part of many CSO treatment facilities, including those in Washington, D.C.; Boston, Massachusetts; Rochester, New York; and Syracuse, New York. The disinfection methods considered for use in combined sewer overflow treatment are chlorine gas, calcium or sodium hypochlorite, chloride dioxide, peracetic acid, ozone, ultraviolet radiation, and electron beam irradiation (USEPA, 1999b and 1999c).

  Three disinfection technologies, chlorine, ozone and ultraviolet radiation were preliminarily evaluated by NYCDEP for the Paerdegat Basin LTCP based on technical feasibility, effectiveness, adverse side effects (e.g. residuals) and comparative cost (NYCDEP, 2005b). Chlorination has greater applicability to CSO than the others on a scale necessary. Chlorination was determined to be by far the most cost effective of the three technologies and to have the advantage of NYCDEP experience. Chlorine disinfection using sodium hypochlorite was considered the preferred option for Paerdegat. However, the results of water quality modeling indicated that the chlorine residual concentrations at the head end of the basin would exceed the NYSDEC acute toxicity standard routinely and the spatial extent of the standard contravention included a substantial portion of the waterbody. Thus the aquatic life use would be impaired for a marginal improvement in bacteria.

  These results were considered to be applicable to Alley Creek because of the similar physical characteristics (narrow tributary, little mixing). Because of the ecosystem risk, the absence of any resultant primary contact use and the operational challenges associated with the highly variable nature of CSOs and water quality (i.e. chlorine demand), disinfection was precluded from consideration in the Paerdegat Basin LTCP. Since the marginal benefit to primary contact recreation expected does not justify the ecosystem risk, disinfection was not included as a control alternative in the Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan analyses.

- Expansion of WPCP Treatment– NYCDEP developed the WWOP Tallman Island WPCP (see Appendix A) per NYSDEC requirements. The WWOP, which is currently under NYSDEC review, provides recommendations for maximizing treatment of flow during wet weather events. The report outlines three primary objectives in maximizing treatment for wet-weather flows: (1) maximize plant wet-weather inflows to prevent overflows from the collection system regulators and provide primary treatment and disinfection to up to 2xDDWF; (2) provide secondary treatment for wet-weather flows up to 1.5xDDWF to maximize pollutant removal during wet-weather events; and (3) maintain reasonably high effluent quality during wet weather while allowing for a subsequent, stable recovery to dry-weather operations. With this WWOP implemented, NYCDEP is implementing this alternative at the Tallman Island WPCP.

Planned upgrades for the Tallman Island WPCP, necessary to comply with the Nitrogen Control Consent Order and address the facility's critical needs, are detailed in Section 3.1.3. Additional treatment plant upgrades and/or expansion of the WPCP were not considered to be feasible CSO alternatives principally due to the site's physical constraints. The WPCP site is bounded on three sides by water and an adjacent residential neighborhood on the fourth side.

Summary of Treatment Technologies

None of the treatment technologies were retained for the Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan alternatives evaluation.

7.3.7 Receiving Water Improvement

Receiving waters such as Alley Creek and Little Neck Bay can also be treated directly with various technologies that improve water quality. These include outfall relocation, aeration, use of flushing water, and dredging.

- <u>Outfall Relocation</u> – Outfall relocation involves moving the combined sewer outfall to another location. For example, an outfall may be relocated away from a sensitive area to prevent negative impacts to that area. Since there is a beach on Little Neck Bay, the bay is a sensitive area. Outfall relocation was considered indirectly when the water quality impact of 100 Percent CSO Reduction was analyzed.

- <u>Aeration</u> – Aeration improves the dissolved oxygen content of the river by adding air directly to the waterbody ("in-stream aeration"). Air could possibly be added in large enough volumes to increase dissolved oxygen in the waterbody to meet the ambient water quality standards. However, shallow water-column depths and soft substrates can limit the effectiveness and applicability of in-stream aeration. Furthermore, depending on the amount of air that would be required to be transferred into the water column, the facilities necessary and the delivery systems could be extensive and impractical. An alternative would be to deliver a lower volume of air and control short term anoxic conditions that may result from intermittent wet weather overflows. NYCDEP has investigated in-stream aeration as a method of meeting dissolved oxygen standards and will be conducting pilot tested this technology within Newtown Creek over the next few years.

  There are several possible disadvantages to installing in-stream aeration in Alley Creek. In addition to the possible logistical problems associated with the infrastructure requirements, vandalism, operation/maintenance and the effectiveness of a forced air diffusion system in a particular application can be difficult to predict. Aeration systems can result in unintended consequences such as an increase in odors, as gasses are stripped and sediment is disturbed. In some cases, dredging is required to establish a sufficient depth for the transfer of oxygen into the water representing a disturbance to bottom habitat. Alley Creek is a narrow, shallow, tidal creek. The headwater riparian area is within Alley Pond Park. In-stream aeration is not applicable in a shallow waterbody. Dredging is not being considered for Alley Creek.

Based upon the above discussion, aeration is not considered to be a feasible alternative for Alley Creek. However, should the pilot testing of this technology in Newtown Creek indicate applicability at a site such as Alley Creek, aeration could be re-evaluated at a future date.

- Flushing Water – The addition of flushing water at the head end of dead-end waterbodies improves circulation, purging pollutant-laden water from the water body while bringing in cleaner water with higher dissolved oxygen. The Gowanus Canal Flushing Tunnel, which was initially completed in 1911, is an existing example of this technology.

- Dredging - Maintenance dredging technology is essentially the dredging of settled CSO solids from the bottom of waterbodies on an interim basis. The settled solids would be dredged from the receiving waterbody as needed to prevent use impairments such as access by recreational boater/kyackers and/or abate nuisance conditions such as odors. The concept would be to conduct dredging periodically or routinely to prevent the use impairment/nuisance conditions from occurring. Dredging would be conducted as an alternative to structural CSO controls such as storage. Bottom water conditions between dredging operations would likely not comply with dissolved oxygen standards and bottom habitat would degrade following each dredging.

Summary of Receiving Water Improvement Technologies

The receiving water improvement methods discussed above: outfall relocation, aeration, introduction of flushing water and dredging, were not retained for consideration in the development of Alley Creek and Little Neck Bay Waterbody/Watershed alternatives.

7.3.8 Solids and Floatables Control

Technologies that provide solids and floatables control do not reduce the frequency or magnitude of CSO overflows, but can reduce the presence of aesthetically objectionable items such as plastic, paper, polystyrene and sanitary “toilet litter” matter, etc. These technologies include both end-of-pipe technologies such as netting and screens, as well as BMPs such as catch basin modifications and street cleaning which could be implemented upstream of outfalls in the drainage area. Each of these technologies is summarized below:

- Netting Devices **-** Netting devices can be used to separate floatables from CSOs by passing the flow through a set of netted bags. Floatables are retained in the bags, and the bags are periodically removed for disposal. Netting systems can be located in-water at the end of the pipe, or can be placed in-line to remove the floatables before discharge to the receiving waters. NYCDEP has installed a floating end of pipe netting system at CSO TI-023 located in Little Bay.

- Containment Booms - Containment booms are specially fabricated floatation structures with suspended curtains designed to capture buoyant materials. They are typically anchored to a shoreline structure and to the bottom of the receiving water. After a rain event, collected materials can be removed using either a skimmer vessel or a land-based vacuum truck. A 2-year pilot study of containment booms was conducted by New York City in Jamaica Bay. An assessment of the effectiveness indicated that the containment booms provided a retention efficiency of approximately 75 percent.

  As part of its Interim Floatables Containment Program (IFCP), NYCDEP currently operates floatables booms at various locations city-wide. There are no IFCP booms in Alley Creek or Little Neck Bay.

- Skimmer Vessels – Skimmer vessels remove materials floating within a few inches of the water surface and are being used in various cities, including New York. The vessels range in size from less than 30 feet to more than 100 feet long. They can be equipped with moving screens on a conveyor belt system to separate floatables from the water or with nets that can be lowered into the water to collect the materials. Skimmer vessels are typically effective in areas where currents are relatively slow-moving and can also be employed in open-water areas where slicks from floatables form due to tidal and meteorological conditions. New York City currently operates skimmer vessels to service containment boom sites and to conduct open-water operations.

- Screens – As discussed previously, several types of screens have utility in CSO abatement, although floatables capture efficiency varies. Manually cleaned bar screens can be located within in-line CSO chambers or at the point of outfall to capture floatables. The configuration of the screen would be similar to that found in the influent channels of small wastewater pumping stations or treatment facilities. In CSO applications very high maintenance requirements and a propensity for clogging may limit their application. Horizontal weir mounted, mechanically cleaned screens use electric motors or hydraulic power packs to power a rake mechanism that is triggered by a float switch in the influent channel. The screened materials are returned to the interceptor sewer. Various screen configurations and bar openings are available depending on the manufacturer. Horizontal screens can be installed in new overflow weir chambers or retrofitted into existing structures if adequate space is available. Electric power service must be brought to each site.

- Baffles - A transverse baffle mounted in front of and typically perpendicular to the overflow pipe can be used to prevent the discharge of floatables by blocking their path to the overflow pipe. As the storm subsides, the floatables are conveyed to downstream facilities by the dry weather flow in the interceptor sewer. The applicability and effectiveness of the baffle depends on the configuration and hydraulic conditions at the regulator structure. Fixed underflow baffles are the simplest type and are basically rigid walls that cross the water surface. A variation on the fixed underflow baffle is the floating underflow baffle developed in Germany. By allowing the baffle to float, a greater range of hydraulic conditions can be accommodated. This technology has not yet been demonstrated in the United States; however, there are operating units in Germany. A hinged baffle with a bending weir offers an additional level of safety through an emergency release mechanism that eliminates emergency by-pass and power requirements thereby resulting in low operation and maintenance costs.

Baffles are being used in CSO applications in several locations including Boston, Massachusetts and Louisville, Kentucky. However, the typical regulator structures in New York City are not amenable to fixed baffle retrofits.

- Catch Basin Modifications - Catch basin modifications consist of various devices to prevent floatables from entering the CSS. Inlet grates and closed curb pieces reduce the amount of street litter and debris that enters the catch basin. Catch basin modifications such as hoods, submerged outlets, and vortex valves, alter the outlet pipe conditions and keep floatables from entering the CSS. Catch basin hoods are similar to the underflow baffle concept described previously for installation in regulator chambers. These devices also provide a water seal for containing sewer gas. The success of a catch basin modification program is dependent on having catch basins with sumps deep enough to accommodate hood-type devices. A potential disadvantage of catch basin outlet modifications and other insert-type devices is the fact that retained materials could clog the outlet if cleaning is not performed frequently enough. This could result in backup of storm flows and increased street flooding. New York City has moved forward with a program to hood all of its catch basins.

Summary of Floatables Control Technologies

Table 7-3 provides a comparison of the floatables control technologies discussed above in terms of implementation effort, required maintenance, effectiveness and relative cost. For implementation effort and required maintenance, technologies that require little to low effort are preferable to those requiring moderate or high effort. When considering effectiveness, a technology is preferable if the rating is high.

Table 7-3. Comparison of Solids and Floatables Control Technologies

Technology	Implementation Effort	Required Maintenance	Effectiveness	Relative Capital Cost
Public Education	Moderate	High	Variable	Moderate
Street Cleaning	Low	High	Moderate	Moderate
Catch Basin Modifications	Low	Moderate	Moderate	Low
Weir-Mounted Screens	Low	Moderate	High	Moderate
Screen with Backwash	High	Low	High	High
Fixed Baffles	Low	Low	Moderate	Low
Floating Baffles	High	Low	Moderate	Moderate
Bar Screens - Manual	Low	High	Moderate	Low
In-Line Netting	High	Moderate	High	High
End-of-Pipe Netting	Moderate	Moderate	High	Moderate
Containment Booms	Moderate	Moderate	Moderate	Moderate

Public education, street cleaning and catch basin modifications are already being implemented in Alley Creek and Little Neck Bay. The Alley Creek CSO Tank, currently under construction, is equipped with a fixed baffle at the downstream end of the tank such that floatables are removed from the tank overflow.

7.3.9 Initial Screening of CSO Control Technologies

Table 7-4 presents a tabular summary of the results of the initial technology screening discussed in the previous sections. Technologies that will advance to the alternatives development screening are noted under the column entitled "Retain for Consideration". These technologies have proven experience and have the potential for producing some level of CSO control.

Other technologies were considered as having a positive effect on CSOs but either could only be implemented to a certain degree or could only provide a specific benefit level and, therefore, would have a variable effect on CSO overflow. For instance, NYCDEP has implemented a water conservation program which, to date, has been largely effective. This program, which will be maintained in the future, directly affects dry weather flow since it pertains to water usage patterns. As such, technologies included in this category provide some level of CSO control but in-and-of-themselves do not provide the level of control sought by this program.

Technologies included under the heading "Consider Combining with Other Control Technologies" are those that would be more effective if combined with another control or would provide an added benefit if coupled with another control technology.

The last classification is for those technologies that did not advance through the initial screening process. In the case of technologies such as infiltration/inflow, the NYCDEP has implemented a program in accordance with federal and state laws that has effectively reduced infiltration/inflow. Inclusion of this control technology in the CSO control program would not provide further tangible benefits. Other technologies like complete sewer separation are simply not feasible in an urban area as extensively built-out as New York City.

Table 7-4. Initial Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Being Implemented	Combine with Other Technologies	Eliminate from Further Consideration
Source Control				
Public Education		X		
Street Sweeping		X		
Construction Site Erosion Control		X		
Catch Basin Cleaning		X		
Industrial Pretreatment		X		
Inflow Control				
Stormwater Detention				X
Street Storage of Stormwater				X
Water Conservation		X		
Infiltration/Inflow Reduction				X

Table 7-4. Initial Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Being Implemented	Combine with Other Technologies	Eliminate from Further Consideration
Green Solutions – See Section 5		X		
Sewer System Optimization				
Optimize Existing System		X		
Real Time Control				X
Sewer Separation				
Complete Separation				X
Partial Separation				X
Rain Leader Disconnection				X
Storage				
Closed Concrete Tanks	X			
Storage Pipelines/Conduits	X	X		
Tunnels				X
Treatment				
Screening				X
Primary Sedimentation		X		
Vortex Separator				X
High-rate Physical/Chemical Treatment				X
Disinfection				X
Expansion of WPCP		X		
Receiving Water Improvement				
Outfall Relocation		X		
In-stream Aeration				X
Maintenance Dredging				X
Solids and Floatable Controls				
Netting Systems				X
Containment Booms				X
Skimming				X
Manual Bar Screens				X
Weir Mounted Screens				X
Fixed baffles		X		
Floating Baffles				X
Catch Basin Modifications		X		

7. 4 ALLEY CREEK AND LITTLE NECK BAY CSO CONTROL ALTERNATIVES

This list of feasible alternatives retained from the preliminary screening as shown in Table 7-4 represents a toolbox from which a suitable technology may be applied to a particular level of CSO abatement. As suggested in USEPA guidance for long-term CSO control plans, water quality modeling was performed for a "reasonable range" of CSO volume reductions, from no reduction up to 100 percent CSO abatement. The technology employed at each level of this range was selected based on engineering judgment and established principles. For example, any of the storage technologies may be employed to achieve a certain reduction, but the water quality response would be the same, so the manner of achieving that level of control is a matter of balancing cost-effectiveness and feasibility. In that sense the alternatives discussed below each represents an estimate of the optimal manner of achieving that particular level of control. All costs presented in this section are in November 2008 dollars.

Storage was the only CSO control technology retained for the development of Alley Creek and Little Neck Bay alternatives. All three technologies considered under this category remain feasible alternatives based on cost-effectiveness and NYCDEP experience, and all three can be combined with other technologies. Closed concrete tanks, such as the storage facilities at Spring Creek, Paerdegat Basin, and Flushing Creek, tend to be more cost-effective for smaller volumes. In-line storage has potential based on review of the sewer system layout, as-builts, contract drawings, other documents, and drainage calculations. Deep storage tunnels are not usually as cost-effective as tanks, but have an advantage where siting issues present a major challenge, such as in an urban environment. For very large volumes, they are often the only feasible approach. The Alley Creek CSO Storage Tank is already under construction, so additional storage was considered in order to achieve CSO volume and overflow event reduction goals.

USEPA CSO Control Policy acknowledges the utility and supports the use of mathematical modeling analyses to improve understanding of waterbody response to CSO controls and other factors affecting the waterbody. The two modeling tools used are the Tallman Island Landside Model and the Alley Creek and Little Neck Bay domain of the East River Tributaries Model.

- <u>Tallman Island Landside Model</u> - The tool used for the evaluation of the effectiveness (reduction in CSO discharge volume and reduction of overflow events) of Alley Creek and Little Neck Bay CSO control alternatives is the Tallman Island InfoWorks CS™ Model (TI Model). This tool was used in an interactive way to both evaluate alternatives and to also develop alternatives as evaluations of technologies were performed. The TI Model was required for the WB/WS Facility Plan alternatives evaluation for both, the Alley Creek and Little Neck Bay and the Flushing Bay and Creek assessment areas. The effects that an alternative for one assessment area had and the other were noted for all analyses. This was particularly important for the Alley Creek and Little Neck Bay since it is located "upstream" of the Flushing Bay CSO Retention Tank. A successful alternative in reducing CSO to Alley Creek could negatively impact results in Flushing Bay. The Alley Creek and Little Neck Bay and Flushing Bay WB/WS Facility Plans were therefore, necessarily developed in close coordination.

  The TI Model also provided the loads for input to the water quality model, ERTM. The loads are calculated by assigning pollutant concentrations to sanitary flow and stormwater. The TI Model calculates the fraction of CSO that is sanitary flow and the fraction that is stormwater for each rainfall/CSO overflow event. Thus the load can be determined using the unique mixture of sanitary and stormwater that comprises each overflow. The TI Model has also been adapted to determine stormwater runoff and loads from non-CSO areas as input to ERTM. In addition, the flow and pollutant loading from the Belgrave WPCP was included.

- <u>Alley Creek and Little Neck Bay Water Quality Model</u> - A modeling framework, described in Section 4.1.3, was constructed and used to simulate water quality in Alley Creek and Little Neck Bay in response to landside discharges of CSO and stormwater along with other inputs. The modeling was developed, calibrated and validated using field data collected during facility planning and other studies. A Baseline Condition was developed so that the impacts of various engineering alternatives could be assessed and compared for a typical precipitation year and for population/wastewater flow projections that are consistent with the planning period. Full-year model simulations were performed for each engineering alternative and the results were compared to those for the Baseline Condition to determine the relative benefit of the engineering alternatives. As suggested in USEPA guidance for long-term CSO control plans, water quality modeling was performed for a host of alternatives providing a reasonable range of CSO volume and frequency reduction and attainment of goals for water-quality and uses.

7.4.1 Alternative 1: Baseline Condition

To properly assess the performance and efficacy of the projected alternatives to achieve the desired water quality and use goals, all model simulations were performed using the same conditions as established for the Baseline Condition to isolate the effects and impacts of each assessed alternative. In this way, all evaluated alternatives were compared on the same basis. The specific design conditions established for the Baseline scenario are discussed in Section 3.4.4 and Section 4.1.3.2. The Baseline Condition represents the state and operation of the sewer system and other facilities in a manner that predates implementation of any long-term CSO abatement plans, but does include implementation of the CSO Policy nine minimum controls and existing permit requirements regarding system wet-weather capacity, and a projected future condition with regard to population and water use. Briefly, the Baseline Condition represents the following:

- Typical annual precipitation data (1988 JFK Airport) having long-term average total rainfall volume and storm duration;
- Dry-weather flow rates reflect year 2045 projections for the Tallman Island WPCP (60.2 MGD);
- Tallman Island WPCP wet-weather capacity of 122 MGD (average sustained flow in 2003, see 3.4.4); Tallman Island WPCP treatment includes the upgrades for BNR.
- Documented sedimentation in sewers; and
- Other environmental conditions (meteorology, tidal conditions, water temperature, salinity, winds, etc.) corresponding to the 1988 calendar year discussed above.

Wet weather flows to the Tallman Island WPCP are limited to less than 2 times DDWF due to conveyance system limitations. These problems were comprehensively examined in the *Facility Plan for Delivery of Wet Weather Flow to the Tallman Island WPCP* (HydroQual, 2005b), and NYCDEP is currently addressing them. Of the recommended measures in the facility plan, modifications to Regulator TI-R09 (increase open area of side-overflow windows, raise weir) and removal of Regulator TI-R10 replacing it with a section of pipe have already been implemented and thus were incorporated into the Tallman Island Model Baseline Conditions. Conveyance Enhancements (CEs) as described in Section 7.4.2 below, were not included in the Baseline. The Alley Creek and Little Neck Bay Baseline Condition is described above for the Tallman Island WPCP and the sewer system. Baseline CSO discharge, stormwater discharge and runoff, and point source (Belgrave WPCP) volumes and pollutant loads to Alley Creek and Little Neck Bay for the one-year Baseline Condition simulation period are described in Section 3. TI Model results for CSOs are summarized below.

Tallman Island WPCP Model Results for Alley Creek and Little Neck Bay CSOs

CSO outfall TI-006, the only CSO outfall discharging to Little Neck Bay, is listed in the Tallman Island SPDES Permit as a CSO outfall because it is the emergency bypass for the 24th Avenue Pump Station (PS). All pump station emergency bypass outfalls are defined by NYSDEC in WPCP SPDES permits as CSO outfalls. A pump station bypass is an emergency relief that protects the pump station in the event of a malfunction and only discharges CSO under unusual operational circumstances such as power failures, extreme flood events, or other conditions that impede pump station operation. The Baseline Condition TI Model results, however, indicate that TI-006, discharges 109 MG/yr of stormwater described in this WB/WS Facility Plan report as “Stormwater Discharge via CSO Outfall”. This description serves to differentiate stormwater that is discharged from a permitted stormwater outfall from stormwater that enters a CSO outfall pipe downstream of a regulator or pump station and is discharged through a CSO outfall such as is the case with TI-006.

There are five CSO outfalls that discharge to Alley Creek: TI-024, TI-007, TI-009, TI-008 and the new Alley Creek Tank outfall, TI-025. Similarly to TI-006, Alley Creek CSO outfall TI-024 is the emergency bypass for the New Douglaston PS. TI-024 does not discharge CSO but discharges 120 MG/yr of stormwater as “Stormwater Discharge via CSO Outfall.”

The Baseline Condition TI Model results also indicate that Alley Creek TI-007, the Old Douglaston PS bypass, and TI-009, the Douglaston Bay PS bypass do not discharge any flow. TI-006, TI-024, TI-007, and TI-009 were not impacted by any of the alternatives evaluated for Alley Creek and Little Neck Bay. For the Baseline and all alternatives, TI-006 and TI-024 discharged 109 MG/yr and 120 MG/yr, respectively, of Stormwater Discharge via CSO Outfall. For the Baseline and all alternatives, TI-007 and TI-009 had no discharge.

For the Baseline Condition, the Alley Creek Tank and its outfall, TI-025 are not included in the TI Model. For the Baseline Condition, TI-008 discharges CSO. However, the CSO flow from the regulator is commingled with stormwater that enters the outfall downstream of the regulator. The Alley Creek Tank Facility Plan includes a new chamber (Chamber 6) that directs CSO to the tank and to TI-008 if the hydraulic capacity of the tank is being exceeded. Chamber 6 is located downstream of the regulator and downstream of the entry of stormwater to the TI-008 outfall pipe. When the tank is activated, the flow from TI-025 and TI-008 will be tank effluent and tank by-pass, respectively. Each alternative affected only TI-025 and TI-008 because these are the only the two outfalls discharging CSO.

7.4.2 Alternative 2: CSO Facility Plan (FP)

The CSO Facility Plan alternative for the Tallman Island WPCP system includes the Flushing Bay CSO Retention Facility and the Alley Creek CSO Retention Facility, as described previously in Section 5. The CSO Facility Plan alternative also includes improvements to the sewer system that are covered as the non-CSO stormwater and non-CSO drainage improvements in the Alley Creek Facility Plan. The CSO Facility Plan Alternative also included Tallman Island system conveyance enhancements (CE). Conveyance enhancements are the recommendations from the *Facility Plan for Delivery of Wet Weather Flow to the Tallman Island WPCP* (HydroQual, 2005b) that are those sewer system changes now embodied into the CSO Consent Order for Flushing Bay and previously part of the Omni IV Order. The end result of these CEs is "Tallman Island WPCP and associated sewer systems are capable of delivering, accepting and treating influent at or above twice the plant design flow during any storm event." These CEs as set forth in the 2008 CSO Order Modification Agreement have milestones of design completion, notice to proceed to construction and construction completion with milestone schedule dates of December 2010, December 2011 and July 2015, respectively.

The Baseline Condition calculations indicate that during runoff events during the design year 517 MG of CSO is generated in the Alley Creek and Little Neck Bay area. The presence of the Alley Creek Tank and its diversion Chamber 6 does not affect the volume of CSO generated. Chamber 6 directs the CSO to the tank and overflows CSO to TI-008 when the tank hydraulic capacity is exceeded. In the design year, 499 MG of the 517 MG generated enters the tank. Of this, 244 MG is captured by the tank for treatment at the Tallman Island WPCP. A volume of 255 MG flows through the tank where settling of solids occurs and floatables are removed prior to discharge at the downstream end of the tank through TI-025. Of the total CSO generated, only 18 MG is discharged as untreated CSO through TI-008. The primary settling tanks at the Tallman Island WPCP operate with a surface overflow rate of 4,000 gpd/sf at peak design flow, similar to all other NYCDEP WPCPs. The Alley Creek Tank surface area is 72,000 sf (600 ft by 120 ft). Therefore, overflows from the tank at rates of less than 288 MGD (12 MG/hr) receive preliminary treatment. An examination of the TI Model output for the WB/WS Facility Plan indicated that essentially all of the hours of discharge from the tank were less than the 12 MG/hr (288 MGD) rate and therefore, receive preliminary treatment. The Alley Creek Tank provides preliminary treatment to 96.5 percent of the CSO flow in the 1988 rainfall design year simulation.

All flows through the Alley Creek Tank are considered to receive preliminary treatment through solids settling and floatables removal with the tank baffle. The tank, therefore, provides a significant reduction of untreated CSO volume discharged to Alley Creek as shown on Table 7-5.

Table 7-5. Alley Creek and Little Neck Bay
Alternatives Performance Summary

CSO Control Alternatives	CSO Outfalls	CSO Volume (MG)	# CSO Events	Percent Reduction of Untreated CSO from Baseline(1)
1. Baseline Condition	TI-008 TI-025	517(1) NA	38 NA	0
2. CSO Facility Plan (FP)	TI-008 TI-025	18 255(2)	4 27	96.5
3. FP + DW Early	TI-008 TI-025	18 201(2)	4 22	96.5
Weir Alternatives				
1. FP + Weir @ TI-025	TI-008 TI-025	19 207(2)	4 24	96.5

Table 7-5. Alley Creek and Little Neck Bay Alternatives Performance Summary

CSO Control Alternatives	CSO Outfalls	CSO Volume (MG)	# CSO Events	Percent Reduction of Untreated CSO from Baseline[(1)]
2. FP + Weir @ Chamber 6	TI-008 TI-025	0[(3)] 256[(2)]	0 27	100
3. FP + Weir @ TI-025+Weir @ Chamber 6	TI-008 TI-025	0[(3)] 208[(2)]	0 24	100
Storage Tank Alternatives				
1. 15 MG Tank	TI-008 TI-025	18 93[(2)]	3 10	96.5
2. 25 MG Tank	TI-008 TI-025	18 34[(2)]	3 5	96.5
3. 30 MG Tank + Weir @ Chamber 6 + Weir @ TI-025	TI-008 TI-025	0[(3)] 0	0 0	100

[(1)] Baseline discharge is 58.8 MG CSO and 458.6 MG stormwater.
[(2)] TI-025 overflows receive preliminary treatment.
[(3)] TI-008 is discharging stormwater only.

It should be noted that, in mid-2006, a change order was approved by NYCDEP to update the design of the Alley Creek Tank and implement the approved changes in construction. The update included raising the elevation of the top of the overflow weir at the downstream end of the tank from +1.46 ft to +2.00 ft to account for a recently determined mean high water (MHW) elevation of +1.70 ft. This change was incorporated into the TI Model to update the CSO Facility Plan Alternative. The effect of the new weir elevation is to increase the volume of the tank slightly from 5 MG to 5.2 MG. The larger volume was used herein.

7.4.3 Alternative 3: Dewater Tank During Storms (DW Early)

The Wet Weather Operating Plan (WWOP) for the Alley Creek CSO Retention Facility (URS, 2003b) provides for the start of tank dewatering 4 hours after the end of a storm. The initiation of dewatering as soon as the tank receives CSO was evaluated. This change in operating procedure resulted in a 54 MG reduction in annual CSO discharge for the one year simulation period and a decrease in CSO events from 27 to 22 as summarized in Table 7-5.

The DW Early Alternative was evaluated as to its impact on performance of the Flushing Bay CSO Retention Facility. An increase in CSO discharged from Flushing Creek outfalls TI-010 and TI-011 (4 MG and 6 MG, 1 percent and 2.5 percent, respectively) was calculated but no increase in the number of CSO events resulted.

Upon NYCDEP review and consideration, the Early Dewatering Alternative was not included in the WQ/WS Facility Plan for the following reasons:

- Increase in CSO overflow from Flushing Creek Tank
- The pumped flow occupies interceptors and impacts the Tallman Island WPCP ability to take in combined sewage from other CSOs not receiving CSO control

- Early dewatering does not decrease the volume of untreated CSO discharged to Alley Creek and Little Neck Bay.

7.4.4 Weir Alternatives

Weir Alternative 1: Bending Weir at TI-025 (Weir @TI-025)

To increase the storage capacity of the tank, an alternative including a bending weir at the end of the Alley Creek tank retrofitted on top of the existing weir (at elevation +2.00) was evaluated. The purpose of this weir is to increase storage capacity and thus reduce CSO to Alley Creek through TI-025 and increase overall CSO capture at the Tallman Island WPCP. Figure 7-6 slows the location of the weir.

Weir Alternative 2: Bending Weir at Chamber 6 (Weir @Chamber 6)

The fixed weir at Chamber 6 serves as the relief for the Alley Creek Tank when flows exceed its hydraulic capacity. The purpose of the bending weir at Chamber 6 is to reduce CSO flow to TI-008. Flow from TI-008 has not gone through the tank and therefore has not had any of the potential solids and floatables removal provided by the retention facility. The Chamber 6 Bending Weir is a retrofit on top of the existing fixed weir. Figure 7-7 shows the location of the weir.

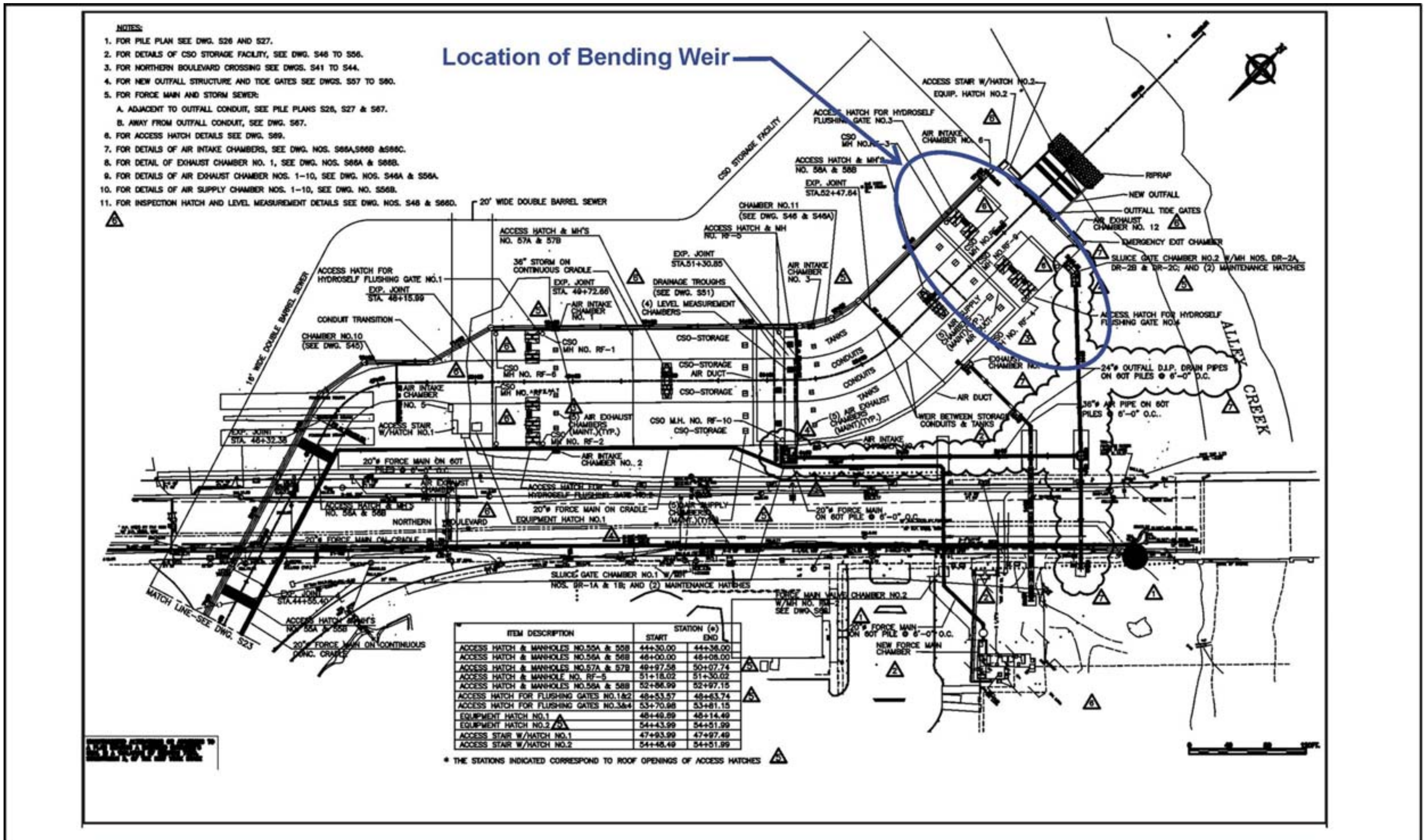
Weir Alternative 3: Bending Weir at TI-025 + Bending Weir at Chamber 6 (Weir @TI-025 + Weir @Chamber 6)

This alternative evaluates the increased capacity of the tank resulting from the bending weir at TI-025 in combination with a bending weir at Chamber 6 to reduce TI-008 discharge.

7.4.5 Storage Tank Alternatives

The alternatives that included weir(s) provided additional CSO reduction at TI-008 but overall, additional CSO reductions and decreases in CSO events were minor. In order to achieve greater reductions, large volume storage alternatives were evaluated. Tanks were selected as the CSO storage technology appropriate for the Alley Creek and Little Neck Bay WB/WS assessment area. All of the CSO discharged to Alley Creek and Little Neck Bay is collected at one location, Chamber 6, and is either captured by the CSO Retention Facility, discharges at TI-025 after passage through the tank or is discharged untreated through TI-008. Providing the storage large enough to substantially reduce or eliminate CSO was evaluated by running the TI Model with larger tanks at TI-025.

The tanks were assumed to occupy larger footprints of the Alley Creek 5.2 MG facility at the same location. Overflow weir elevations at Chamber 6 and at the downstream end of the tanks were assumed to be the same as the current CSO Facility Plan. Three storage tank alternatives were evaluated. These alternatives were developed through a sensitivity analysis of TI Model system responses to tank size to achieve target CSO reductions and overflow events. Tank sizes of 15 MG (Storage Tank Alternative 1), 25 MG (Storage Tank Alternative 2) and 30 MG (Storage Tank Alternative 3) were evaluated.



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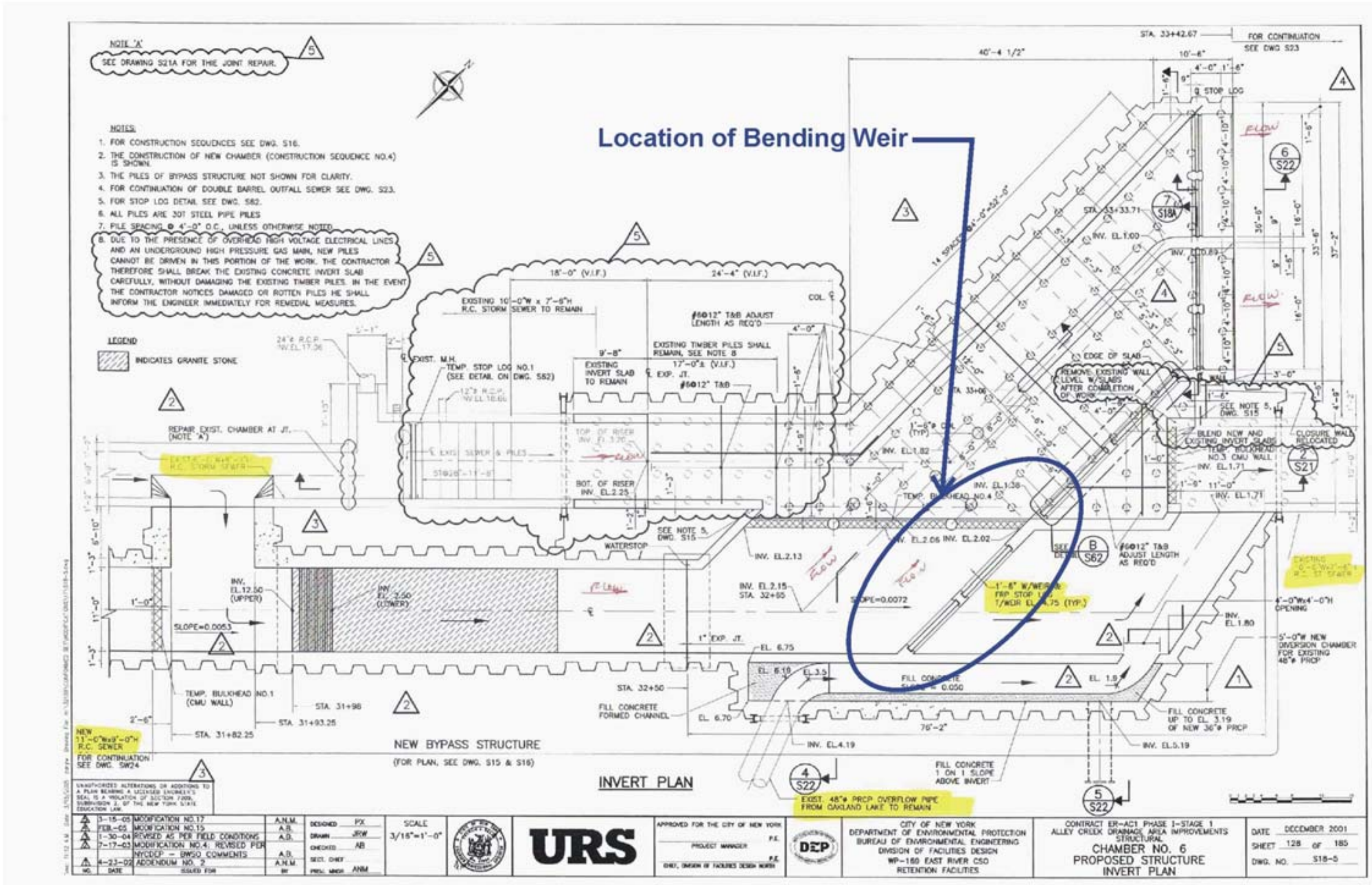
Location of Bending Weir at TI-025

FIGURE 7-6



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Location of Bending Weir at Chamber #6

FIGURE 7-7

A 30 MG tank was required in order to achieve 100 percent reduction of Alley Creek and Little Neck Bay CSO discharge and zero CSO events at TI-025. The 30 MG tank also needed to include raising the fixed weir elevation at Chamber 6 by 0.75 ft plus using a bending weir at Chamber 6. These additional controls (designated as ++) were required to eliminate CSO discharge from TI-008, the CSO relief at Chamber 6. This alternative is also referred to as the 100 Percent CSO Reduction Case.

7.4.6 Summary of Performance for Alley Creek and Little Neck Bay CSO Control Alternatives

Table 7-5 summarizes performance results of Baseline, Updated Alley Creek CSO Facility Plan (FP), the three weir alternatives (Weir Alternative 1 - FP + Weir @ TI-025, Weir Alternative 2 - FP + Weir @ Chamber 6 and Weir Alternative 3 – FP + Weir @ TI-025 + Weir @ Chamber 6) and the three large storage tank alternatives (15 MG Tank, 25 MG Tank and 30MG Tank++). The CSO from TI-008 and TI-025 for each alternative is included with the number of CSO events and percent reduction of untreated CSO volume for the alternative when compared to the Baseline Condition.

The performance of the CSO control alternatives will be discussed in relation to the resultant water quality improvement and benefit to waterbody uses in Section 7.5 and cost in Section 7.6.

7.5 ALLEY CREEK AND LITTLE NECK BAY ALTERNATIVES, RESULTANT WATER QUALITY

The TI Model calculates pollutant loads for the CSO, stormwater, direct runoff and Tallman Island WPCP discharge sources for each of the Alley Creek and Little Neck Bay CSO Control Alternatives. The TI Model loads are then used as input to the ERTM water quality model that is described in Section 4.1.3. Comparison of the resultant water quality associated with the Alley Creek and Little Neck Bay Alternatives to Baseline Condition and CSO Facility Plan water quality and waterbody use targets are the key in the Alternatives Evaluation.

Alley Creek and Little Neck Bay existing conditions were described in Section 4 based on available data. However, as an LTCP Project methodology, to evaluate Alley Creek and Little Neck Bay alternatives, Baseline Condition water quality for each waterbody is established as an initial point of comparison. Baseline Condition for dissolved oxygen and pathogens were presented in Section 4. Resultant water quality in Alley Creek and Little Neck Bay Alternatives will be compared to Baseline.

The 100 percent CSO Removal Alternative (best case scenario) is defined in the LTCP Project as the removal of the CSO flow and load discharged to Alley Creek and Little Neck Bay and calculation of the resultant water quality. The CSO flow and its associated load (discharged from TI-008) were taken out of the ERTM Model for the analysis of the 100 Percent CSO Removal scenario. A comparison of resultant water quality from Alley Creek and Little Neck Bay Alternatives to the 100 Percent CSO Removal scenario as a “best case” scenario and CSO Facility Plan is also relevant.

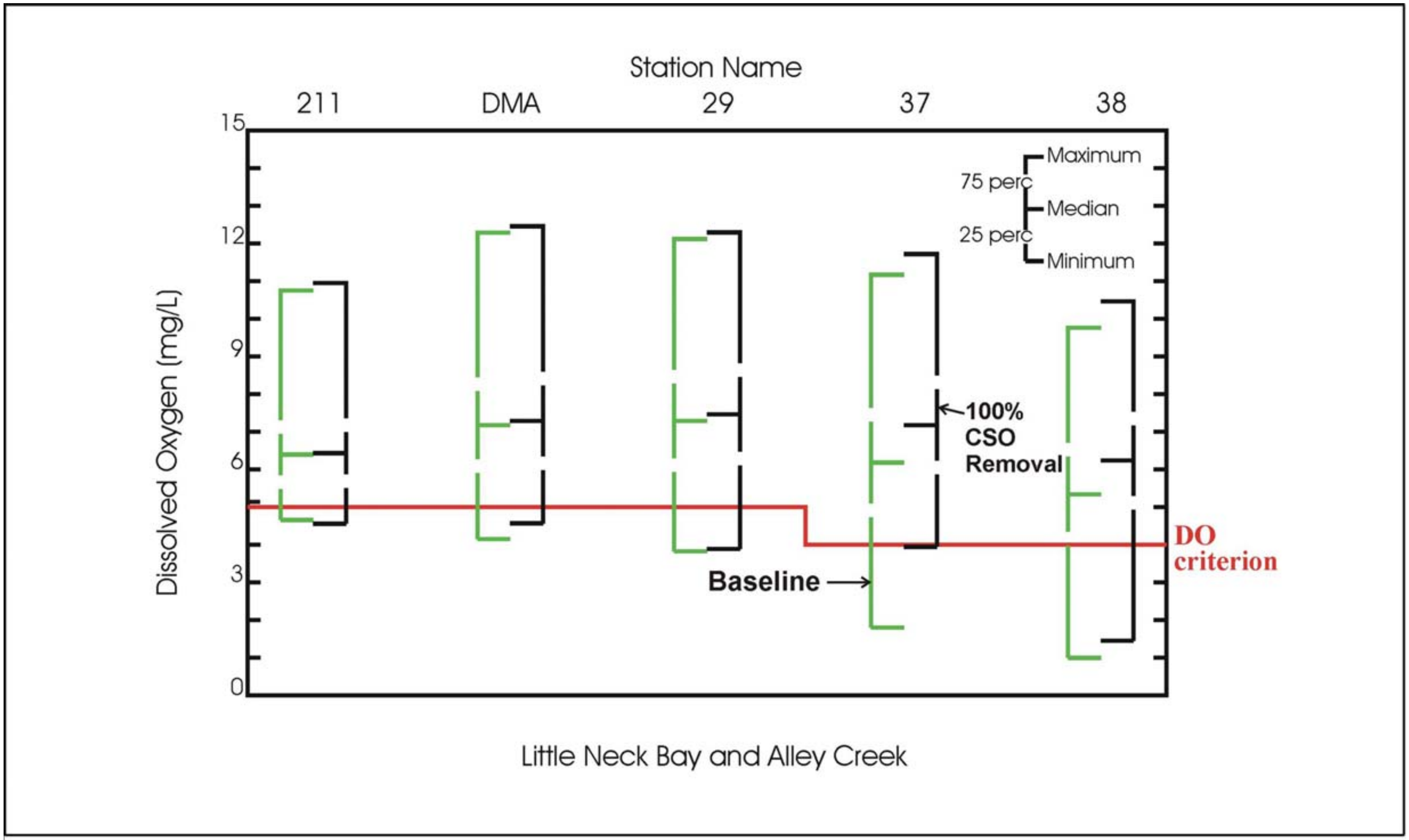
7.5.1 Dissolved Oxygen

The dissolved oxygen results for the Baseline Condition case are compared with the 100 Percent CSO Removal scenario on Figure 7-8 for the Summer season, June through August. Figure 4-15 is a location map of Alley Creek and Little Neck Bay with the ERTM model grid and selected historic and current sampling locations indicated.

The ERTM model results for the one-year simulation period are post-processed based on hourly average and daily average dissolved oxygen calculated throughout the year. The range and statistics of hourly average dissolved oxygen calculated during Summer (June-August) are shown in Figure 7-8. The stations selected are Station 38 (head of Alley Creek), Station 37 (near the mouth of Alley Creek), Station 29 (Little Neck Bay, near Douglaston), the Douglas Manor Association Beach (DMA), and a location in the middle of Little Neck Bay (Station 211). For each station, model results are taken from the bottom water column layer, the location within the water that generally has the lowest dissolved oxygen. The top, middle, and bottom horizontal lines of each box represent the maximum, median, and minimum values, respectively. In addition, the top and bottom breaks in the vertical lines represent the 75th and 25th percentile values, respectively. The dissolved oxygen standards of a minimum of 4.0 mg/L in Alley Creek and daily average 4.8 mg/L in Little Neck Bay have been included. The left side of the box plot at each station is the Baseline. The right side at each location is the 100 Percent CSO Removal scenario.

For the Summer months (June through August), it can be seen that in Little Neck Bay the results indicate that the dissolved oxygen calculated for the Baseline Condition and 100 Percent CSO Removal is essentially the same. The “minimum” in both cases is less than the 4.8 mg/L dissolved oxygen standard at these Little Neck Bay locations. It should be noted that well over 75 percent of the dissolved oxygen results are greater than 4.8 mg/L. In Alley Creek, the 100 Percent CSO Removal results in essentially all summer hours being greater than 4.0 mg/L at the mouth of creek. This is in comparison to the Baseline minimum of 2.0 mg/L. Calculated dissolved oxygen results are more than 1.0 mg/L higher at the 75th percentile, median and 25th percentile values. At the head of Alley Creek (Station 38), the increase in calculated dissolved oxygen between Baseline and 100 Percent CSO Removal is on the order of that calculated at the mouth of Alley Creek. At the head of Alley Creek the minimum dissolved oxygen for both cases, however, is less than 2.0 mg/L.

On a monthly basis, Alley Creek is calculated to experience dissolved oxygen less than 4.0 mg/L during some of the hours of the months of April through September of the Baseline Condition year. For the 100 Percent CSO Removal scenario, dissolved oxygen is calculated to be less than 4.0 mg/L during some of the hours for the months of May through September. Similarly, on a monthly basis, Little Neck Bay is calculated to experience dissolved oxygen less than 4.8 mg/L during some of the hours of the months June through September for both the Baseline Condition case and 100 Percent CSO Removal scenario.



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Comparison of 100% CSO Removal with Baseline Summer (June-August)- Dissolved Oxygen

FIGURE 7-8

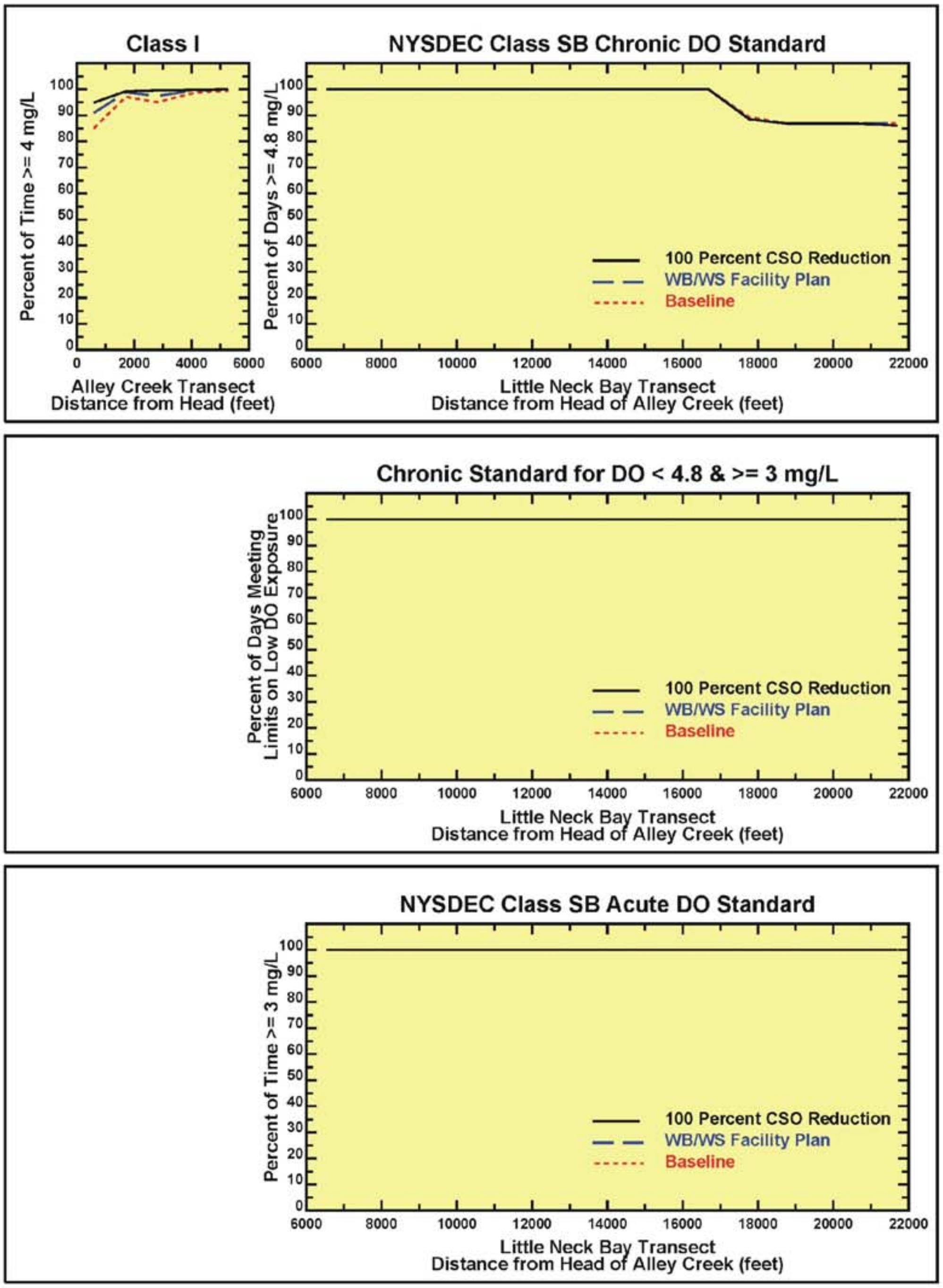
7.5.1.1 Component Analysis of Dissolved Oxygen Impairment

The comparison of dissolved oxygen results for the Baseline and 100 Percent CSO Removal scenario on Figure 7-8 indicates that the dissolved oxygen in Little Neck Bay is not impacted by CSO loads. The results from both cases are essentially the same throughout the bay. Removal of the CSO does not change dissolved oxygen significantly. During the Summer months when the Baseline calculated dissolved oxygen is less than 4.8 mg/L for some of the summer hours, removal of the CSO load does not increase the dissolved oxygen. Dissolved oxygen less than 4.8 mg/L is not the result of CSO. The likely cause of dissolved oxygen less than 4.8 mg/L is the stormwater load. Dissolved oxygen impairment in Little Neck Bay, although relatively small as measured by the percent of time dissolved oxygen is less than 4.8 mg/L, is the result almost exclusively of stormwater.

In contrast, the dissolved oxygen in Alley Creek is impacted by CSO as shown in Figure 7-8. Removal of the CSO load results in increased dissolved oxygen in the creek. At the mouth (Station 37), the dissolved oxygen improvement is evidenced by the minimum values above 4.0 mg/L during Summer (and Autumn) for the 100 Percent CSO Removal scenario. At that location, therefore, all of the dissolved oxygen impairment is due to CSO. At the head of Alley Creek, the dissolved oxygen is influenced by CSO load; however, the dissolved oxygen increase resulting from the CSO removal is not sufficient to raise the minimum above 4.0 mg/L at the head of Alley Creek at all times. The stormwater load to Alley Creek continues to cause low dissolved oxygen after 100 percent of the CSO is removed. During the summer the dissolved oxygen is less than 4.0 mg/L approximately 25 percent of the time. Removing CSO reduces the amount of time that dissolved oxygen is less than 4.0 mg/L to approximately 10 percent of the time. The dissolved oxygen impairment at the head of Alley Creek is therefore, caused roughly 60 percent by CSO to 40 percent by stormwater.

7.5.1.2 Alley Creek Dissolved Oxygen for Alternatives

Alley Creek and Little Neck Bay dissolved oxygen was determined for the alternatives. Figure 7-9 is a spatial presentation of dissolved oxygen results for Baseline, CSO Facility Plan, and 100 Percent CSO Removal Alternatives along the transect depicted on Figure 4-15. The transect begins at the head of Alley Creek. At a distance 6,000 feet from the head of Alley Creek, Little Neck Bay begins. The transect continues through Little Neck Bay and for approximately 0.5 miles into the East River. Figure 7-9 is a summary of dissolved oxygen results on a summer season (June through August) basis. The left side panel presents the results for Alley Creek expressed as percent of the time the dissolved oxygen is greater than 4.0 mg/L. At the head of Alley Creek, for the Baseline Condition, dissolved oxygen is greater than 4.0 mg/L 85 percent of the time during the summer. On a summer season basis, the dissolved oxygen is greater than 4.0 mg/L 91 percent of the time for the WB/WS Facility Plan and 95 percent of the time for the 100 Percent CSO Removal case. Therefore, at the head of Alley Creek, 100 Percent CSO Removal does not result in achieving 4.0 mg/L all of the time. At the mouth of Alley Creek all of the alternatives are the same with dissolved oxygen greater than 4.0 mg/L for 100 percent of the time.



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Summer Dissolved Oxygen for Alternatives Comparison, Alley Creek/Little Neck Bay Transect

Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

FIGURE 7-9

7.5.1.3 Little Neck Bay Dissolved Oxygen for Alternatives

The right side panels on Figure 7-9 present the dissolved oxygen results for Little Neck Bay. The top panel expresses as percent the days that the daily average dissolved oxygen is greater than or equal to 4.8 mg/L, the NYSDEC Class SB dissolved oxygen chronic standard. All of the alternatives evaluated were calculated to have daily average dissolved oxygen of 4.8 mg/L, 100 percent of the summer days at the head of the bay. As Little Neck Bay transitions to the East River at the mouth, however, daily average dissolved oxygen is greater than or equal to 4.8 mg/L for 87 percent of the summer days.

The middle panel on Figure 7-9 presents the chronic dissolved oxygen portion of the SB standard. For the summer days when the daily average dissolved oxygen was calculated by the model to be less than 4.8 mg/L but greater than 3.0 mg/L, the cumulative fractions of allowable days of low dissolved oxygen exposure for the next 66 days were calculated. A cumulative sum of fractions less than 1.0 means that the chronic dissolved oxygen standard was achieved with respect to allowable periods of exposure to low dissolved oxygen. For the Baseline in Little Neck Bay, 100 percent of summer days meet the allowable limits on low dissolved oxygen exposure (100 percent of the fractions calculated were less than 1.0), The WB/WS Facility Plan and 100 Percent CSO Removal cases also meet chronic dissolved oxygen limits 100 percent for the summer of the design year. Thus even though there were days when the average daily dissolved oxygen was less than 4.8 mg/L, (as shown on the top right panel, near the East River), the juvenile fish survival use was protected.

The bottom right hand panel of Figure 7-9 presents the percent of time that dissolved oxygen is greater than or equal to 3.0 mg/L, the NYSDEC acute dissolved oxygen standard for SB waters. All cases were calculated to be greater than 3.0 mg/L for Little Neck Bay, during the summer season of the design year.

7.5.2 Aquatic Life Use Assessment

The water quality model results indicate that the Class SB aquatic life use is being achieved in Little Neck Bay. Aquatic life use is not being impaired by CSO. Daily average dissolved oxygen is calculated to be below 4.8 mg/L, Class SB standard near the East River but the periods of exposure to dissolved oxygen less than 4.8 mg/L did not result in an aquatic life use impairment. Removal of 100 percent of the CSO, however, did not result in any significant change from Baseline Condition. The CSO Control alternatives evaluated produced essentially the same dissolved oxygen concentrations as Baseline and 100 Percent CSO Removal in Little Neck Bay. The aquatic life use of Little Neck Bay is being achieved as determined from the dissolved oxygen analysis.

Alley Creek dissolved oxygen Baseline Condition indicates that some of the time during the months of April through September, dissolved oxygen is calculated to be below 4.0 mg/L. At the mouth of the creek, however, dissolved oxygen is calculated to be greater than 4.0 mg/L 100 percent of the time. At the head of the creek, dissolved oxygen median is calculated to be generally 1.0 mg/L less than at the mouth. The minimum dissolved oxygen is also generally less at the head than at the mouth of Alley Creek. In Alley Creek, improvement in dissolved oxygen is calculated to occur under the 100 Percent CSO Removal scenario. The median dissolved oxygen in Alley Creek improves on the order of 1.0 mg/L. This improvement, however, is not sufficient to result in dissolved oxygen that is always greater than 4.0 mg/L. The CSO Facility Plan Alternative increased dissolved oxygen in Alley Creek to varying degrees along the creek as shown on Figure 7-8 and Figure 7-9. Although the dissolved oxygen in Alley Creek is not greater than 4.0 mg/L at all times, the model results indicate that the dissolved oxygen is greater than 3.0 mg/L essentially at all times. Thus a fish survival use is being achieved.

7.5.3 Bacteria and Recreation Use

Alley Creek

The bacteria results for Baseline Condition indicate that Alley Creek has a monthly geometric mean total coliform of less than 10,000 per 100 mL for all months of the year. The monthly geometric mean fecal coliform, similarly, is less than 2,000 per 100 mL for the entire year. There is no enterococcus standard for Class I waterbodies. The monthly geometric mean total coliform of 10,000 and monthly geometric mean fecal coliform of 2,000 per 100 mL are the bacteria water quality standards for secondary contact recreation although bacteria standards are not applicable to Alley Creek. The Baseline bacteria load from all sources, including CSO, does not result in any secondary contact use impairment. Recall that the opportunities for secondary contact recreation in Alley Creek are very limited because water-based contact recreation is not provided by Alley Pond Park.

DMA Beach

As described in Section 4, the Baseline Condition loads of pathogens consisted of CSO and stormwater discharges to Alley Creek and Little Neck Bay. Localized sources associated with potentially failing septic systems, water fowl, etc. were not included in the Baseline Condition or Alternatives analysis. The DMA Beach location for Baseline Condition was calculated to have a 30 day moving geometric mean of enterococcus less than the 35 per 100 mL Class SB standard during the months of June through August, the NYCDOHMH bathing season. The number of hours for Baseline with enterococcus greater than 104 per 100 mL was 220 out of a total of 2,208 hours. All months at the DMA Beach location calculated monthly median and monthly 80 percent total coliform less than 2,400 and 5,000 per 100mL, respectively. The monthly geometric mean of fecal coliform was less than 200 per 100 mL. The designated use and existing use at the DMA Beach is primary contact recreation, swimming. The 100 Percent CSO Removal scenario reduces total and fecal coliform at the DMA Beach somewhat. The hours of enterococcus greater than 104 per 100 mL (guidance value, not a standard) decreased from 220 to 140. Similar results for enterococcus, total and fecal coliform were calculated for the CSO Facility Plan and Weir Alternatives as compared to the Baseline.

Bayside Marina

The bacteria Baseline results for location S64, near the Bayside Marina, were similar to results at DMA Beach. All months of total coliform monthly median, total coliform 80 percent and fecal coliform monthly geometric means are less than 2,400, 5,000 and 200 per 100 mL. The 30-day moving geometric mean of enterococcus is less than 35 per 100 mL. The number of hours of enterococcus greater than 501 per 100 mL was 63 for the Baseline. The 100 Percent CSO Removal scenario hours greater than 501 per 100 mL was 40. The influence of CSO bacteria load is not as evident at this location because of the relatively long distance from the

CSO outfall in Alley Creek. The stormwater loads are responsible for the overall level of enterococcus, total coliform and fecal coliform calculated in Little Neck Bay.

The designated recreation use at this location as well as all of Little Neck Bay, Class SB, is primary contact. The enterococcus of 501 per 100 mL for alternatives evaluation at this location, however, reflects the existing level of primary contact use as infrequent. Secondary contact recreation opportunities are provided in Little Neck Bay by the public marina at Bayside and fishing along the shoreline walkway and bikeway located along the Bay's western shore.

7.6 COST ESTIMATES FOR ALLEY CREEK AND LITTLE NECK BAY ALTERNATIVES

General costing estimates for many of the CSO control technologies under consideration for the LTCP Project were developed as part of the project in order to standardize the cost estimating procedure. Based on previous costing experience and following estimating assumptions used in previous projects for the NYCDEP (URS Construction Services, 2004), Hard Costs, Soft Costs and Ancillary Costs for each CSO control technology were combined into the Probable Total Project Cost (PTPC). For cost comparison in this section and Section 8, the costs developed in 2005, included in prior submittals, have been escalated to November 2008 values.

The major feature of the Alley Creek CSO Facility Plan is the 5.2 MG Tank now under contract and construction. The bid price cost of the CSO control elements provided by URS, lead construction consultant and escalated to November 2008 is $31.3 million. As described in Section 5.7 the CSO Control elements in the Alley Creek project are part of a larger drainage improvement project. The bid price for AC-1 (upstream sewers and tank construction) was $93.1 million, AC-2 (pump station upgrade and activation of tank) was $29.9 million and AC-3 (wetlands restoration) was $12.7 million, a total project cost of $136 million.

7.6.1 Weir Costs

PTPCs (2005 costs) were developed for bending weirs using manufacturer's specifications and the length of weir required at Chamber 6 and at CSO outfall TI-025. Model FSK700 Hydrovex flap spring-loaded weirs, manufactured by John Meunier, Inc. (St-Laurent, Quebec) were simulated in the Tallman Island WPCP InfoWorks model by using head to discharge relationships provided by the manufacturer.

The bending weir for Chamber 6 was assumed to be a retrofit on top of the existing weir in Chamber 6 that provides the relief for the Alley Creek CSO Tank by directing CSO to TI-008. The weir is a 1.5 ft. high spring loaded bending weir installed in four sections, two 8 ft. long sections and two 10 ft. long sections. Similarly, the bending weir at TI-025 is a 1.5 ft. high spring loaded bending weir installed in 12 sections, each 10 ft. long. The PTPC for the bending weir at Chamber 6, escalated to November 2008, is $504,000 and for the bending weir at TP-025 is $1,570,000. These costs were used for all Weir Alternatives and were considered conservative if static weirs were used, not bending weirs.

7.6.2 Tank Costs

Costs for the large tanks that were evaluated as Alley Creek and Little Neck Bay CSO Control Alternatives were based on general cost curves as a function of tank size. This set of curves also includes consideration of a cost factor associated with construction as a function of site characteristics. Costs of tanks under construction and/or planned throughout NYC were used as input for the curves. The Alley Creek and Little Neck Bay CSO Storage Tank alternatives costs were based on "moderate" site conditions. The costs of the 15 MG Tank, 25 MG Tank and 30 MG Tank are $369M, $503M and $558M, respectively, in November 2008 dollars. The costs of additional features such as bending weirs, and raised weir height at Chamber 6 necessary in conjunction with the 30 MG tank to achieve elimination of CSO for TI-008, were considered negligible in relation to the basic tank.

The costs of the Alley Creek and Little Neck Bay tanks estimated by this method are necessarily very rough estimates. However, any CSO Control Alternative for Alley Creek, developed to achieve 80 to 100 percent CSO reduction and elimination of CSO events needed to be large and therefore, costly. The rough estimate for tank costs is sufficient to evaluate costs of the large tanks relative to the CSO Facility Plan and Weir Alternatives. Table 7-6 is a summary of the cost for each of the Alley Creek and Little Neck Bay Alternatives.

Table 7-6. Performance and Cost Summary of Alternatives

Alley Creek and Little Neck Bay CSO Control Alternative	Alternative Total				
	CSO Discharge (MG)	# CSO Events	Percent CSO Reduction from Baseline	Percent Reduction of Untreated CSO(1)	Cost (Millions)
1. Baseline Condition	517(2)	38	0	0	NA
2 CSO Facility Plan (FP)	273	27	47	96.5	$31.3
Weir Alternatives					
1. FP + Weir @ TI-025	226	24	56	96.5	$32.9
2. FP + Weir @ Chamber 6	256	27	51	100	$31.8
3. FP + Weir @ TI-025 + Weir @ Chamber 6	208	24	60	100	$33.4
Storage Tank Alternatives					
1. 15 MG Tank	111	10	79	96.5	$369
2. 25 MG Tank	52	5	90	96.5	$503
3. 30 MG Tank +Weir @ TI-025 + Weir @ Chamber 6	0	0	100	100	$558

(1) TI-025 overflows receive preliminary treatment.
(2) Includes 58.8 MG of CSO and 458.6 MG of stormwater.

Table 7-6 summarizes the weir alternatives and storage tank sizes that were evaluated, the percentage of CSO volume reduction that each alternative would provide, the number of CSO events that would occur, and the PTCP cost (November 2008) for each alternative.

7.7 ALLEY CREEK AND LITTLE NECK BAY ALTERNATIVES EVALUATION RESULTS

The CSO Policy (USEPA, 1994a) requires that long-term CSO control planning "will consider a reasonable range of alternatives" that would achieve a range of CSO control levels, up to 100 percent CSO capture. The policy further states that the "analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance" and that the selected alternative must provide "the maximum pollution reduction benefits reasonably attainable."

In addition, the presence of the DMA Beach in Little Neck Bay, defines Little Neck Bay as a sensitive area. Federal CSO Policy requires that the long-term CSO control plan give the highest priority to controlling overflows to sensitive areas. For such areas, the CSO Policy indicates the LTCP should: (a) prohibit new or significantly increased overflows; (b) eliminate or relocate overflows that discharge to sensitive areas if physically possible, economically achievable, and as protective as additional treatment, or provide a level of treatment for remaining overflows adequate to meet standards; and (c) provide reassessments in each permit term based on changes in technology, economics, or other circumstances for those locations not eliminated or relocated (USEPA, 1995b).

The performance of each of the Alley Creek and Little Neck Bay Alternatives in the reduction of untreated CSO volume and reducing the number of CSO events (see Section 7.4), resultant water quality (see Section 7.5) and cost of each alternative (see Section 7.6) were reviewed to assist in selection of an alternative as the Alley Creek and Little Neck Bay WB/WS Facility Plan that meets the overall CSO Policy requirements and those requirements specific to the sensitive DMA Beach, Little Neck Bay area.

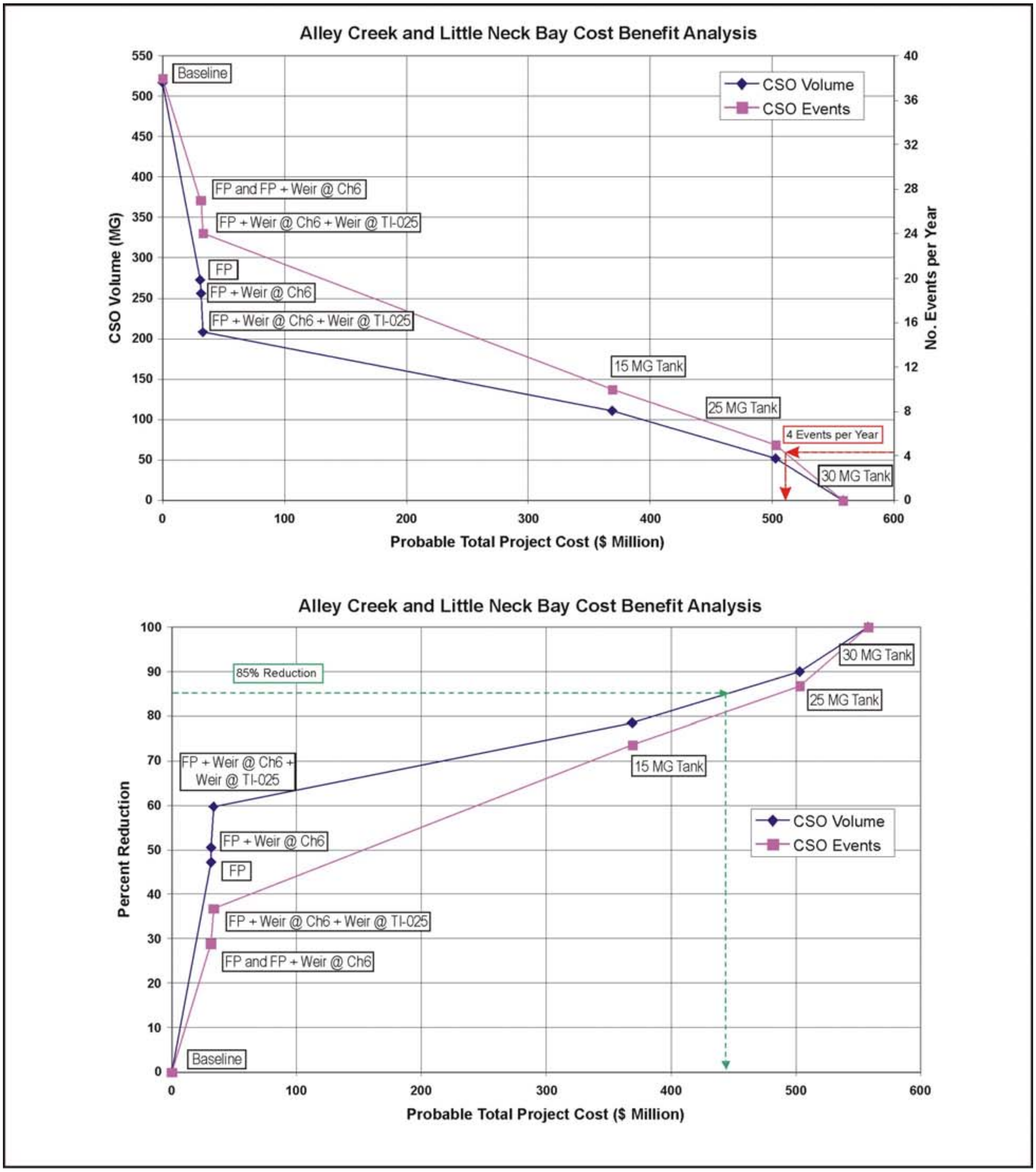
7.7.1 Performance Evaluation Results

The performance of each of the alternatives as a function of cost is presented on Figure 7-10. The top panel of the figure shows CSO volume (annual discharge during Baseline Condition year) and number of CSO events. The CSO Facility Plan alternative and weir alternatives range in cost from $31.3M to $33.4M. The larger tanks needed to reduce CSO events to 10 (15 MG), 5 (25 MG) and 0 (30 MG) cost $369M, $503M, and $558M, respectively. To reduce the number of CSO events to 4 per year would require more than 25 MG of storage at a cost of more than $510M. The bottom panel of Figure 7-10 expresses performance as percent reduction of Baseline CSO volume and percent reduction in Baseline CSO events as a function of cost. To reduce CSO volume by 85 percent needs more than 20 MG of storage at a cost of approximately $430M.

All of the flow through the tank, captured and overflow receives preliminary treatment through settling of solids. Floatables removal is accomplished via the baffle at the end of the tank. The CSO Facility Plan, therefore, reduces the untreated CSO discharge by 96.5 percent.

7.7.2 Dissolved Oxygen Evaluation Results

The water quality results for the Alley Creek CSO Alternates were expressed as a function of cost in order to define the relationship of cost to resultant water quality benefit. Figure 7-11 presents the dissolved oxygen results. Probable Total Project Cost is on the horizontal axis. Percent of time that dissolved oxygen is greater than 4.0 mg/L is presented on a



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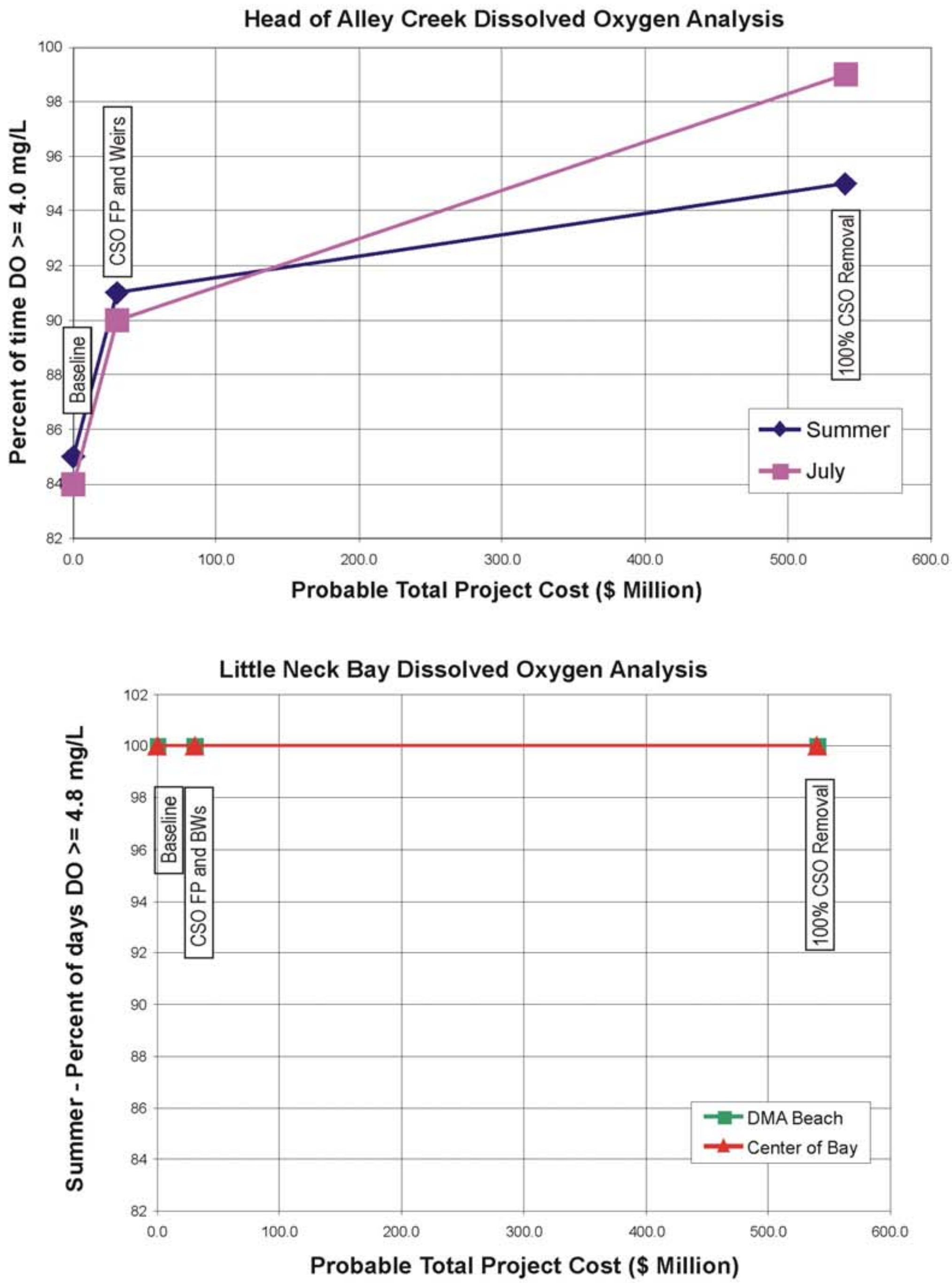
CSO Discharge Reduction vs. Costs for Evaluated Alternatives

Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

FIGURE 7-10



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Alley Creek and Little Neck Bay Dissolved Oxygen, Cost-Benefit

Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

FIGURE 7-11

summer season basis and for the month of July, the critical summer month. The percent of time dissolved oxygen is greater than 4.0 mg/L increases for the CSO Facility Plan and Weir alternatives as compared to the Baseline on a summer season basis. The minimum calculated dissolved oxygen values increase for the CSO Facility Plan and Bending Weir alternatives compared to the Baseline Condition. This increase at a cost of $31.8M to $33.4M is one half of the improvement that 100 Percent CSO Removal provides over Baseline. The CSO Facility Plan and Weir alternates represent the level of dissolved oxygen improvement and cost which is the "knee of the curve". Further dissolved oxygen improvement is minimal and is only achieved at significant cost.

The water quality results for Little Neck Bay as a function of cost are presented on the bottom panel of Figure 7-11. Cost of alternative is the horizontal axis with percent of summer days that daily average dissolved oxygen is greater than 4.8 mg/L as the vertical axis. The results of alternatives at two locations are shown, DMA Beach and near the center of the bay. The center of the bay results indicate that for all of the alternatives, including Baseline, the daily average dissolved oxygen is greater than 4.8 mg/L 100 percent of the time during the summer. The conclusion for Little Neck Bay is that the summer daily average dissolved oxygen is always greater than 4.8 mg/L. The CSO Facility Plan and Weir Alternatives and 100 Percent CSO Removal may improve the dissolved oxygen in Little Neck Bay compared to Baseline but that cannot be expressed in terms of percent of summer days greater than 4.8 mg/L. The dissolved oxygen benefit and cost for Alley Creek and Little Neck Bay alternatives are summarized on Table 7-7.

Table 7-7 - Alternatives Evaluation, Dissolved Oxygen Benefit and Cost

Probable Total Project Cost	Alley Creek and Little Neck Bay Alternative	Head of Alley Creek				Little Neck Bay	
		Percent of Time DO >4.0 mg/L		Percent of Time DO >3.0 mg/L		Summer Percent of Days DO >4.8 mg/L	
		Summer	July	Summer	July	DMA Beach	Center of Bay
$0	Baseline Condition	85	84	100	100	100	100
$31.3M	CSO Facility Plan	91	90	100	100	100	100
$31.8M	FP + Weir @ Chamber 6	91	90	100	100	100	100
$32.9M	FP + Weir @ TI-025	91	90	100	100	100	100
$558M	100 Percent CSO Removal	95	98	100	100	100	100

7.7.3 Bacteria Evaluation Results

Enterococcus

The water quality enterococcus results were evaluated for Little Neck Bay at DMA Beach and near the Bayside Marina. To provide an evaluation comparison for the CSO control alternatives, a summary of hours with enterococcus concentrations greater than 104 and 501 per 100 mL for each alternative is presented in Table 7-8 and shown on Figure 7-12. The head of Alley Creek, DMA Beach and Bayside Marina locations were selected as representative of Alley

Table 7-8. Alternatives Evaluation, Pathogens Benefit and Cost

Enterococcus (Entero)

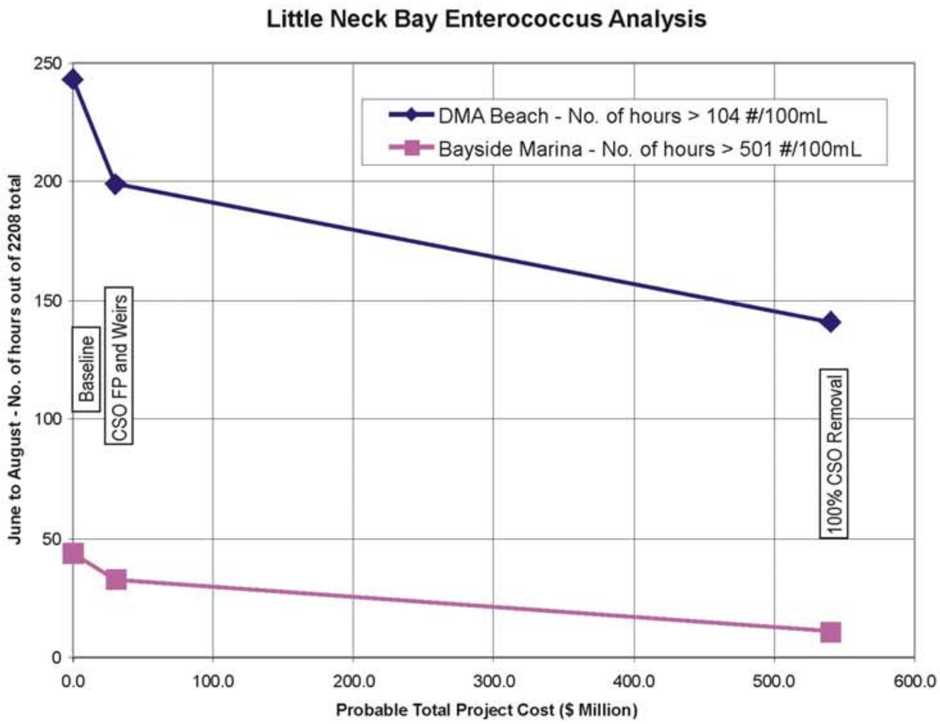
		Location				
		DMA Beach		**Bayside Marina**		**Head of Alley Creek**
		Standard: 30 Day Moving GM <35/100 mL	**Standard: 30 Day Moving GM <35/100 mL**	**Standard: 30 Day Moving GM <35/100 mL**		**No Standard for Class I**
Probable Total Project Cost	**Alternative**	**June, July, August Max. Geometric Mean Entero org/100 mL**	**Number of June, July, August Hours (Out of 2,208 hrs) Entero > 104 org/100 mL**	**June, July, August Max. Geometric Mean Entero org/100 mL**	**Number of June, July, August Hours (Out of 2,208 hrs) Entero > 501 org/100 mL**	
$0	Baseline	17	243	17	44	NA
$31.3M	CSO FP	12	199	13	33	NA
$558M	100 Percent CSO Removal	10	141	12	11	NA

Total Coliform (TC)

		Location				
		DMA Beach		**Bayside Marina**		**Head of Alley Creek**
		Standard: Monthly Median ≤ 2,400/100 mL	**Standard: 80 Percent Monthly Values ≤ 5,000/100 mL**	**Standard: Monthly Median ≤2,400/100 mL**	**Standard: 80 Percent Monthly Values ≤ 5,000/100 mL**	**Standard: Monthly Geometric Mean <10,000/100mL**
Probable Total Project Cost	**Alternative**	**July Median TC / 100 mL**	**Percent of time July TC <5,000**	**July Median TC / 100 mL**	**Percent of Time July TC <5,000**	**July Geometric Mean TC / 100 mL**
$0	Baseline	190	92	215	94	1,280
$31.3M	CSO FP	90	95	140	95	900
$558M	100 Percent CSO Removal	80	99	115	96	400

Fecal Coliform (FC)

		Location		
		DMA Beach	**Bayside Marina**	**Head of Alley Creek**
		Standard: Geometric Mean ≤ 200/100 mL	**Standard: Geometric Mean ≤ 200/100 mL**	**Standard: Geometric Mean ≤ 2,000/100 mL**
Probable Total Project Cost	**Alternative**	**July Geometric Mean FC (org/100 mL)**	**July Geometric Mean FC (org/100 mL)**	**July Geometric Mean FC (org/100 mL)**
$0	Baseline	29	21	210
$31.3M	CSO FP	19	14	190
$558M	100 Percent CSO Removal	18	13	110



CSO FP and Weirs:
Alley Creek Tank and
Weir Alternates

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Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

Douglas Manor Association Beach and Little Neck Bay, Enterococcus Cost-Benefit

FIGURE 7-12

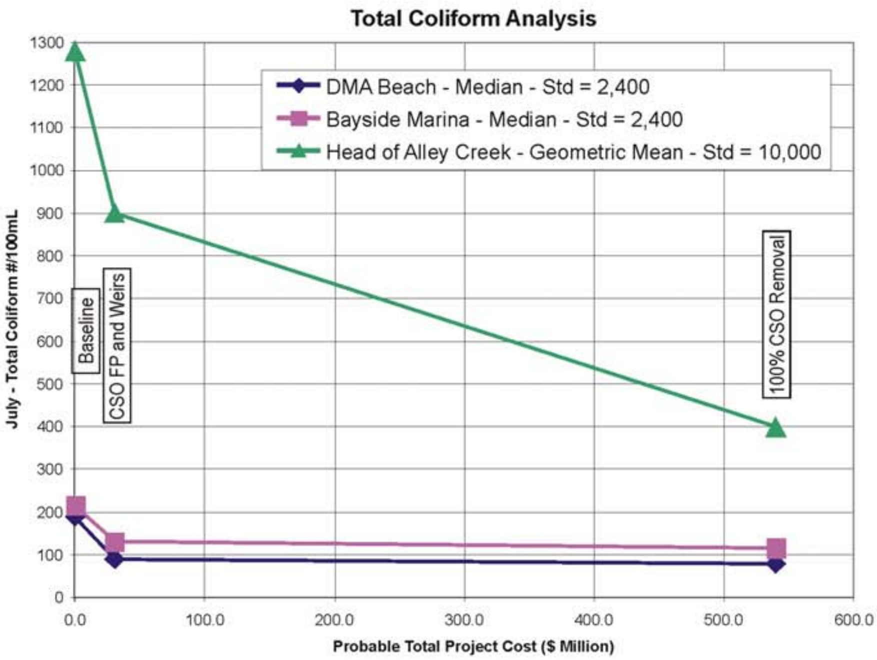
Creek, the important, "sensitive area" beach location and an area of access to the secondary contact recreation opportunities in Little Neck Bay, respectively. For all of the alternatives including Baseline, the 30-day moving geometric mean was less than 35 per 100mL in Little Neck Bay during the June through August bathing season. The maximum value of the 30-day moving geometric mean enterococcus is presented on Table 7-8 at DMA Beach and Bayside Marina. It can be seen that the maximum value decreases by approximately one-third for the 100 Percent CSO Removal case compared to Baseline. This indicates that at these locations for the design year calculation CSO represents one-third of the source and stormwater two-thirds. As noted in Section 4.5.2.1, localized sources of pathogens such as potential failing septics, recreational boat discharges, and water fowl are likely significant pathogen sources. These localized sources, however, are not included in the ERTM model which performs calculations at a spatial scale appropriate for CSO and stormwater evaluation.

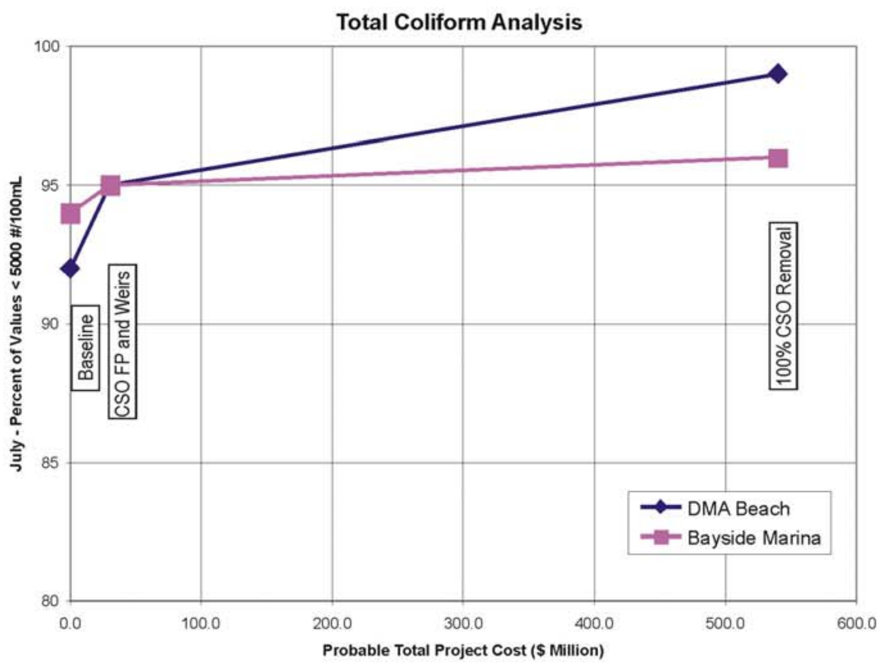
The number of hours during the summer bathing season June through August (out of a total of 2208 hours) is presented as a function of cost on Figure 7-12. The enterococcus results for the DMA Beach are number of bathing season hours that enterococcus is greater than 104 per 100 mL. The Baseline number of 243 is reduced to 199 for the CSO Facility Plan alternative and reduced to 141 with 100 Percent CSO Removal, at associated costs of $31.3M and $558M, respectively. Similarly, the number of bathing season hours greater than 501 per 100 mL is presented for the location near Bayside Marina. The 63 hours at Baseline is reduced to 54 hours and 40 hours for the CSO Facility Plan alternative and 100 Percent CSO Removal, respectively. The conclusion for enterococcus for the DMA Beach is that 100 Percent CSO Removal does not result in the enterococcus being less than 104 per 100 mL at all times during the summer bathing season. Further reduction in the hours with enterococcus greater than 104 per 100 mL, could only be accomplished by addressing bacteria sources other than CSO. However, more than half of the potential reduction in hours with enterococcus greater than 104 per 100 mL that was calculated for 100 Percent CSO Removal when compared to Baseline, can be achieved with the CSO Facility Plan and Weir Alternatives.

Similarly, in the remainder of Little Neck Bay where primary contact recreation is infrequent, the CSO Facility Plan alternative achieves a reduction in bathing season hours with enterococcus greater than 501 per 100 mL almost one-half the reduction expected from 100 Percent CSO Removal compared to Baseline. The CSO Facility Plan and Weir Alternatives represent the enterococcus reduction and cost which is the "knee of the curve." Further enterococcus improvement is minimal and is only achieved at significant cost.

Total Coliform

Total coliform results relating cost of CSO control alternatives to total coliform improvement in July are presented on Figure 7-13 and summarized in Table 7-8. The top panel includes results from the Little Neck Bay locations at DMA Beach and near Bayside Marina and the head of Alley Creek. July total coliform per 100mL for the Little Neck Bay locations are the median. The total coliform standard in Little Neck Bay, Class SB, is a monthly median less than 2,400 per 100 mL. All monthly medians in Little Neck Bay calculated for the one year simulation period were well below 2,400 per 100 mL. It can be seen that July monthly median total coliform Baseline at DMA Beach, 190 per 100 mL, could be reduced to 80 with 100 Percent CSO Removal. However, a reduction to 90 is calculated for the CSO Facility Plan





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Douglas Manor Association Beach, Little Neck Bay and Alley Creek, Total Coliform Cost-Benefit

Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

FIGURE 7-13

alternative at a cost of $31.3M compared to $558M for 100 Percent CSO Removal. Results are similar for the Bayside Marina location.

The total coliform monthly geometric mean in Alley Creek is less than the Class I standard of 10,000 per 100 mL for all alternatives at all times. The Baseline July geometric mean, 1,280 per 100 mL, is calculated to be reduced to 900 per 100 mL for the CSO Facility Plan alternative and 400 per 100 mL for 100 Percent CSO Removal.

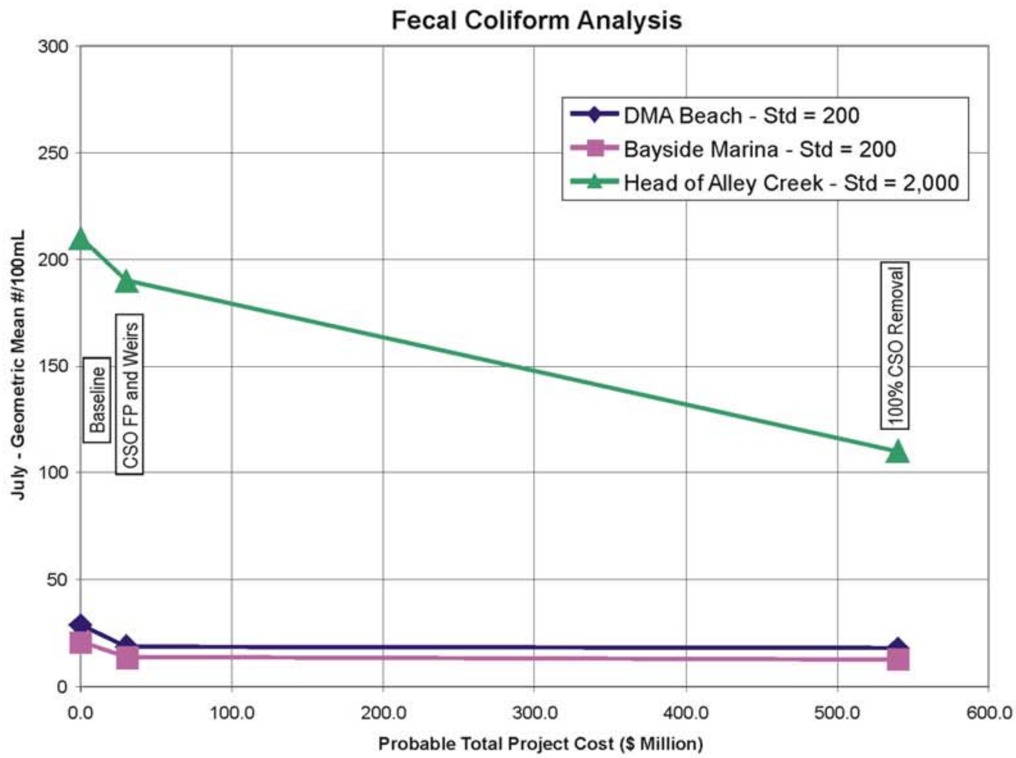
The bottom panel of Figure 7-13 presents the percent of total coliform less than 5,000 per 100 mL for July for the Little Neck Bay locations. It should be noted that all Little Neck Bay locations had at least 80 percent, of monthly total coliform less than 5,000 per 100 mL, the Class SB standard. At the DMA Beach and the location near Bayside Marina, the percent of July total coliform less than 5,000 per 100 mL increase slightly from the Baseline percentage for both the CSO Facility Plan and 100 Percent CSO Removal alternatives. The CSO Facility Plan alternate represents the reduction in total coliform (improvement greater than meeting standards) and cost which is the "knee of the curve". Further total coliform reduction is minimal and is only achieved at significant cost.

Fecal Coliform

Results for fecal coliform cost-benefit analysis are presented on Figure 7-14 and summarized in Table 7-8. The July geometric mean of fecal coliform in Alley Creek, at DMA Beach and Bayside Marina for CSO Control alternatives is shown as a function of cost. All monthly fecal coliform geometric means were less than 2,000 per 100 mL for Alley Creek and less than 200 per 100 mL for Little Neck Bay. It can be seen from Figure 7-14 that the CSO Facility Plan alternative results in a decrease in the July geometric mean of fecal coliform. The 100 Percent CSO Removal scenario results in only slightly lower values. Fecal coliform results are presented for Alley Creek. Similarly to enterococcus and total coliform evaluations, the CSO Facility Plan alternative represents the reduction in fecal coliform (improvement greater than meeting standards) and cost which is the "knee of the curve". Further reduction in fecal coliform is minimal and is only achieved at significant cost.

7.8 RECOMMENDED WATERBODY/WATERSHED FACILITY PLAN

The resultant water quality results discussed in Section 7.6 in conjunction with the performance vs. cost comparison leads to the selection of the alternative that includes the Alley Creek Tank and a static weir to raise the bypass fixed weir at Chamber 6 as the Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan. The static weir at Chamber 6 will further reduce CSO discharge from TI-008. A recent hydraulic analysis of the tank and Chamber 6 indicated that a static weir can provide the equivalent CSO reduction to TI-008 as the bending weir without an increased risk of upstream flooding (HydroQual 2008). Therefore, the Waterbody/Watershed Facility Plan includes the use of a stop log to raise the elevation of the Chamber 6 fixed overflow weir to TI-008 from +4.75 ft to +5.75 ft in lieu of a 1.5 ft high bending weir. The hydraulic analyses also concluded that addition of more stop logs to further increase the fixed weir overflow height was not required to achieve TI-008 CSO reduction goals. However, NYCDEP Bureau of Water and Sewer Operation (BWSO) is evaluating whether a second stop log or portion of a second stop log can safely be added at this location. Upon approval by BWSO, a second stop log will be added.



CSO FP and Weirs:
Alley Creek Tank and
Weir Alternates

New York City
Department of Environmental Protection

Douglas Manor Association Beach, Little Neck Bay and Alley Creek, Fecal Coliform Cost-Benefit

Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan

FIGURE 7-14

7.9 PROTECTION OF A SENSITIVE AREA, DMA BEACH IN LITTLE NECK BAY

There is a sensitive area present in Little Neck Bay (a permitted bathing beach) as defined by the USEPA Long Term CSO Control Plan Policy. The Waterbody/Watershed Facility Plan and LTCP will, therefore, address the USEPA policy requirements: (a) prohibit new or significantly increased overflows; (b) eliminate or relocate overflows that discharge to sensitive areas if physically possible, economically achievable, and as protective as additional treatment, or provide a level of treatment for remaining overflows adequate to meet standards; and (c) provide reassessments in each permit term based on changes in technology, economics, or other circumstances for those locations not eliminated or relocated (USEPA, 1995a).

"(a) Prohibit new or significantly increased overflows,"

There will be no new or significantly increased overflows in the immediate vicinity of the DMA beach. The WB/WS Facility Plan reduces CSO volume by 51 percent and reduces CSO overflow events.

"(b) Eliminate or relocate overflows that discharge to sensitive areas if physically possible, economically achievable, and as protective as additional treatment, or provide a level of treatment for remaining overflows adequate to meet standards;"

The Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan reduces CSO volume by 51 percent and reduces untreated CSO volume by 100 percent for the design year.

The alternatives analyses concluded that elimination (or relocation) of CSO overflows is not economically achievable and that elimination of CSOs does not result in water quality that meets water quality standards at DMA Beach at all times. The remaining CSOs were shown to have relatively little influence on DMA Beach water quality. The WB/WS Facility Plan provides water quality improvements in dissolved oxygen and it is calculated that daily average dissolved oxygen meets chronic and acute standards 100 percent of the time during the critical summer period. The 30-day geometric mean enterococcus is calculated to be less than 35 per 100 mL at all times. The WB/WS Facility Plan monthly median total coliform is less than 2,400 per 100 mL at all times. The percent of total coliform concentrations that are less than 5,000 per 100 mL is greater than 80 percent for all months at DMA Beach. The monthly geometric mean of fecal coliform levels is less than 200 per 100 mL at all times. The water quality improvements resulting from the WB/WS Facility Plan compared to Baseline are similar to improvements expected to result from 100 Percent CSO Removal. The determination of pollutant loads into Alley Creek and Little Neck Bay (Section 3) and the CSO control alternatives evaluation (Section 7) indicate that stormwater control is required for additional water quality improvement and the control of localized pathogen sources from the DMA Beach area is needed for non-impaired swimming use.

"(c) Provide reassessments in each permit term based on changes in technology, economics, or other circumstances for those locations not eliminated or relocated."

The Alley Creek and Little Neck Bay Waterbody/Watershed Facility Plan includes provisions for the reassessment of CSOs TI-025 and TI-008 for their impact on DMA Beach water quality and the opportunity to further reduce CSO overflows to Alley Creek and Little Neck Bay (Section 8.5). CSO Outfalls TI-006, TI-007, TI-009, and TI-024 were calculated to have no CSO discharge during the 1988 one year simulation. Should CSO discharge at these outfalls, the impact on DMA Beach will be evaluated. (Note: TI-007 to be eliminated as per NYSDEC mandate.)

Available NYCDOHMH DMA Beach Monitoring data will be reviewed in conjunction with the LTCP post-construction monitoring program data, and beach advisories and closures will be included in the DMA Beach assessment report.

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